Concrete

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Light-Weight Aggregate Permits Erection of Two Additional Stories

Use of Light-Weight Aggregate for Fireproofing, Floors and Backup in Adding 14 Stories to Present Building for the Southwestern Bell Telephone Co. at Kansas City Permitted the Addition of 14 Stories Instead of 12—Concrete Proportions and Control Methods—Data on Haydite Concrete

IN 1920 the Southwestern Bell Telephone Company, St. Louis, Mo., built their present Kansas City Headquarters building at 11th and Oak Streets.

The original structure was 14 stories high and so designed that the height could be increased to take care of future requirements. At that time no definite plans were made as to the exact number of stories which could be added. This, however, would depend upon live floor loads, being designed for office space or equipment rooms.

In the interval between 1920 and the present, a number of outlying exchanges had been built and it was decided that only one story of the new addition should be devoted to equipment space, requiring a much heavier live-load than for office design.

As the original building was a steel frame structure, this necessitated the same type in the additional stories to be added.

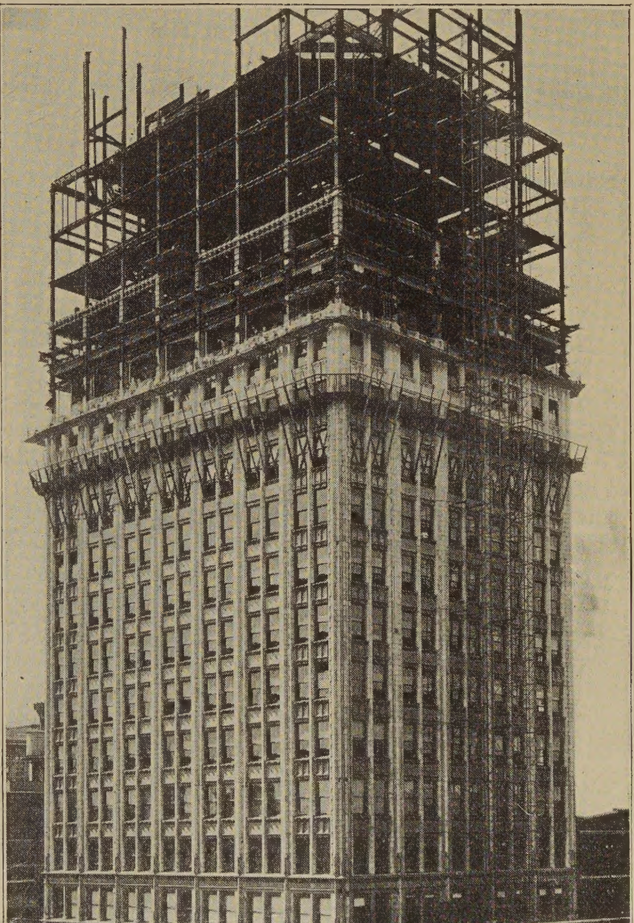
Dead-Load Reduced

Having determined the floor loading, the total height was therefore governed by the dead-load. If the dead-load could be reduced, extra height could be secured. To gain the maximum saving in dead-load, the specifications called for all terra cotta to be backed up with Haydite brick and that all fireproofing of columns and concrete floors and all reinforced concrete be made of Haydite concrete, using a 1:2:3 mix.

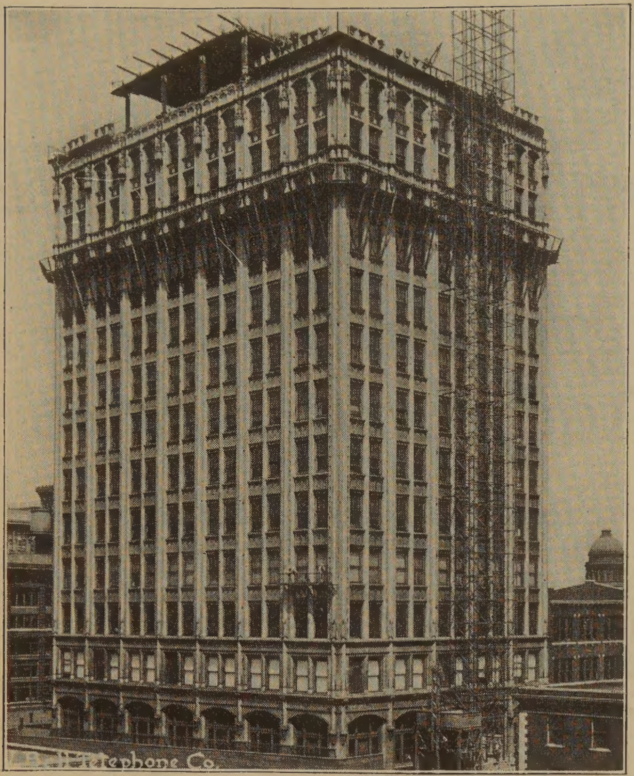
Haydite is a light-weight aggregate produced by a heat treatment of clay or shale. As the raw material is burned a fusion and expansion occur, thus forming a Haydite clinker which is broken down and then screened into fine and coarse to be used as concrete aggregate. The mix of 1:2:3 has a weight of approximately 100 lbs. per cu. ft. and the cement-Haydite brick of standard size have a weight of 3 lbs. each.

The saving in dead-load by the use of this material made it possible to secure two additional stories and 14 stories are being added to the present structure, making a total height of 28 stories.

The specifications call for No. 6 Haydite as fine aggre-



Light-weight aggregates were used for the concrete floors, the steel fireproofing and the backup masonry units when 14 floors were added to the old Kansas City telephone building



The start of the job, April 30, 1928

gate and ¾-in. for coarse. A typical sieve analysis is given below:

SIEVE ANALYSIS

Sieve Size	No. 6	¾-in.
¾-in.	-------	00.00
⅜-in.	-------	25.80
No. 4	-------	92.60
No. 8	11.25	99.00
No. 14	39.45	100.00
No. 28	61.75	100.00
No. 48	79.75	100.00
No. 100	88.50	100.00

This gives a fineness modulus of 2.8 for the fine and 6.17 for the coarse. Dry and rodded weights are 63.6 lbs. and 48.6 lbs., respectively.

The following tables give weights for fine and coarse with different percentages of moisture:

Per Cent Moisture	Weight per Cu. Ft. No. 6 Fine	Weight per Cu. Ft. ¾-in. Coarse	
None	63.6	48.6	Dry and Rodded
None	58.7	42.9	Dry and Loose
2½	58.1	45.5	
5	56.9	46.0	
7½	56.4	46.8	
10	56.1	46.7	
12½	54.3	47.7	
15	54.1	49.4	
17½	52.6	48.4	
20	54.2	49.2	
22½	54.4	49.4	
25	55.2	------	
27½	56.8	------	
30	57.3	------	
32½	59.2	------	
35	61.1	------	
37½	64.1	------	
40	65.6	------	

Both fine and coarse Haydite will carry a much larger percentage of moisture than ordinary aggregates and it is, therefore, always recommended that they be thoroughly wet down before being used.

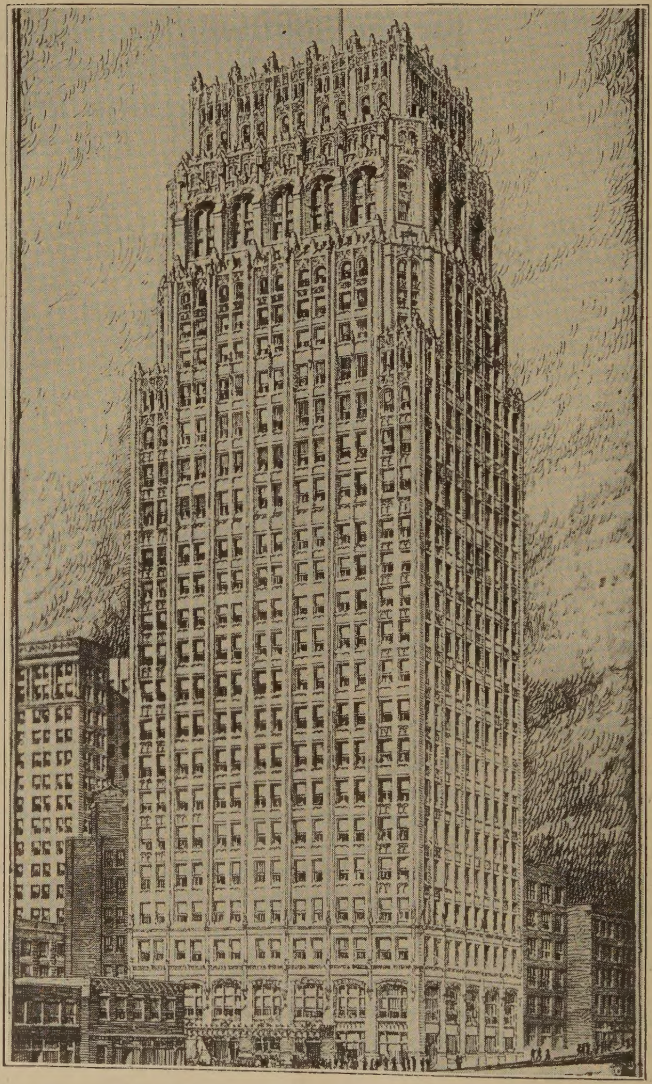
It is specified that slump shall not be more than 6 in., using a total water content of 6 gal. per sack of cement and that the proportion of fine aggregate may be varied upon instruction of architect to compensate for bulking.

To secure control, weighing hoppers and water measuring device have been installed.

Concrete Plant

Concrete plant consists of a 1 cu. yd. electric driven Marsh Capron mixer; a 40 cu. yd. type "V" Butler bin, one set weighing hoppers and one vertical bucket elevator attached, capacity 60 cu. yds. per hour.

For hoisting, there has been installed one Triple American Tubular steel elevator 423 ft. high, having one passenger compartment, one material cage and one concrete bucket.



How the completed building will appear

Architects for the building were: Hoit Price and Barns, Kansas City, Mo.; associate architect, I. R. Timlin, St. Louis, Mo.; consulting engineer, C. A. Glass, Kansas City, Mo. The general contractor was the Swenson Construction Co. of Kansas City, Mo.

Proportion Aggregates by Weight in New Kansas City Products Plant

Compact, Well-Designed New Plant Built by the Kansas City Duntile Co., at Kansas City—Three Kinds of Aggregates Combined by Weight with Traveling Measuring Hopper—Make Duntile and Roofing Tile—Plant Arrangement and Operation

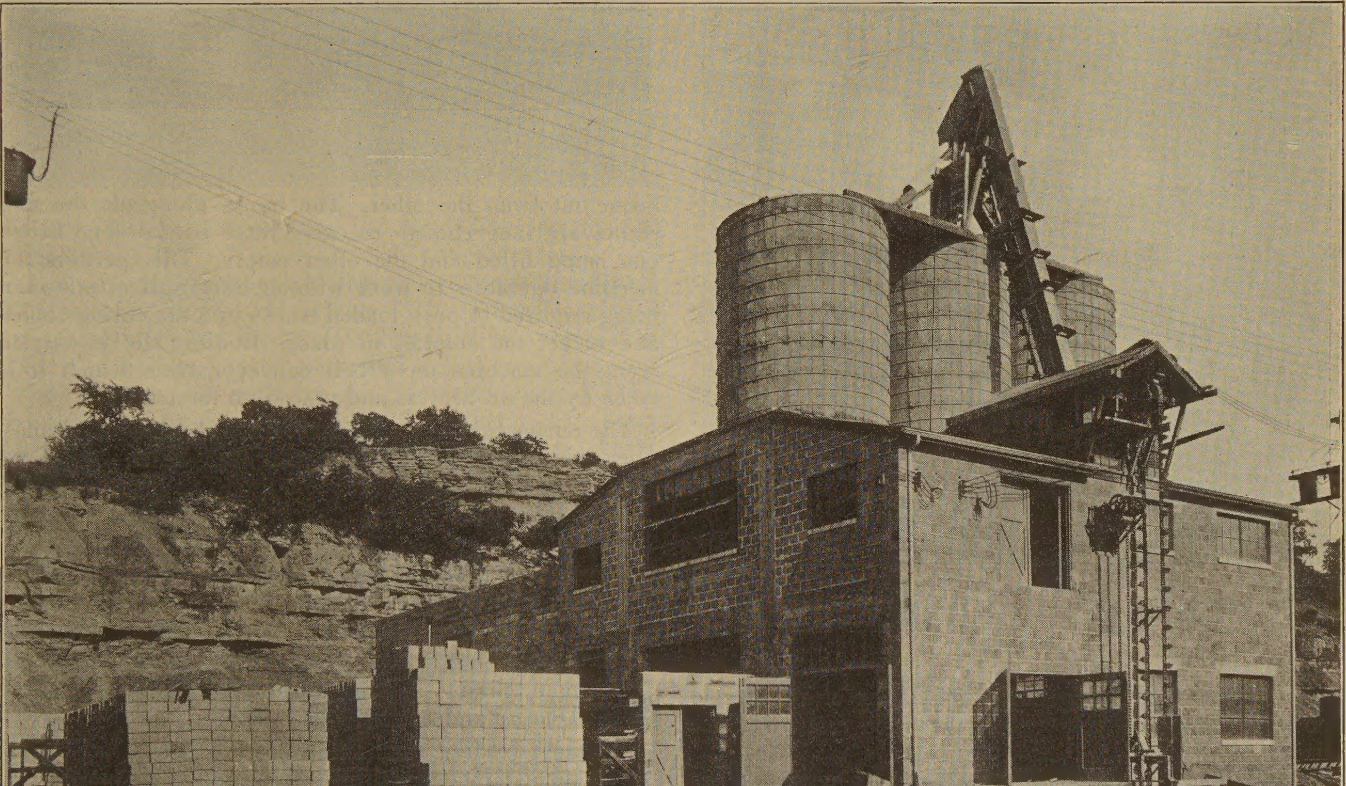
By C. E. SWANSON
Secretary and Manager, Kansas City Duntile Co.

THERE are several features in the design of the recently completed new plant of the Kansas City Duntile Company at Kansas City, Mo., that have a definite influence on economy of operation and quality of the product produced. Among the unusual features is the fact that all aggregates are proportioned by weight—an arrangement having been perfected that permits great flexibility and accuracy of proportioning.

The Plant Building

The new building, shown in one of the accompanying illustrations, is a two-story structure throughout. The central portion along the length of the building is the main workhouse. It is of reinforced concrete design and supports the three concrete stave silos used for storing the aggregates. This reinforced concrete frame also supports the mixer and the proportioning equipment.

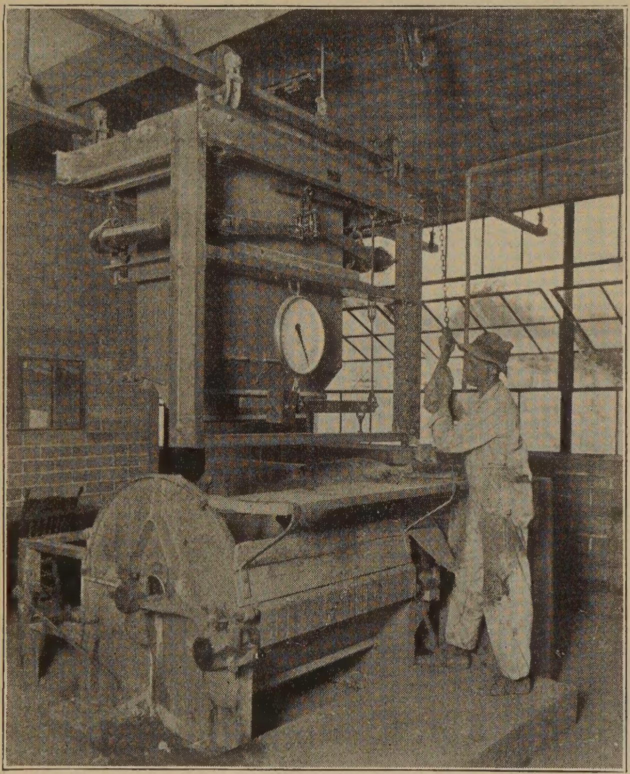
The three stave silos are 13 ft. in diameter and 16 ft. high. One of the silos contains coarse sand; one crushed limestone graded from ½-in. to ¼-in.; the other crushed limestone from ¼-in. down to dust. The staves used were made by the Interlocking Cement Stave Silo Company



General view of the new plant of the Kansas City Duntile Co. Note the elevators used to convey the aggregates from the track pit into the silos of Wichita, Kan.

Aggregates are received in hopper-bottom railroad cars on the sidetrack paralleling the plant and dumped into a track hopper. A 2-stage, single-chain, Link-Belt bucket elevator takes the materials from the pit and places them into the storage silos. As shown in the illustration, the first stage is vertical and the second on an incline, so arranged that the conveyor does not run through the plant. The total distance elevated is approximately 75 ft. Eight-inch by 5-in. buckets on 16-in. centers are used, giving the elevator a capacity of about 20 tons per hour. An arrangement at the discharge end of the elevator permits the materials to be diverted into any one of the three silos.

The silos are equipped with steel draw-off bin bottoms, each opened by a chain which can be operated from the mixer floor. A traveling proportioning hopper, equipped with a Fairbanks-Morse scale, operates on an overhead Cleveland tramrail. The hopper holds 3000 lbs. of material and was designed by the Kansas City Millwright Company. It is pushed under each silo in succession, receives the proper amount of material, and then discharges through a quick action gate into the 14-ft. Besser mixer. The overhead track hangs from the ceiling of the second floor, extending directly under the silos and over the mixer.



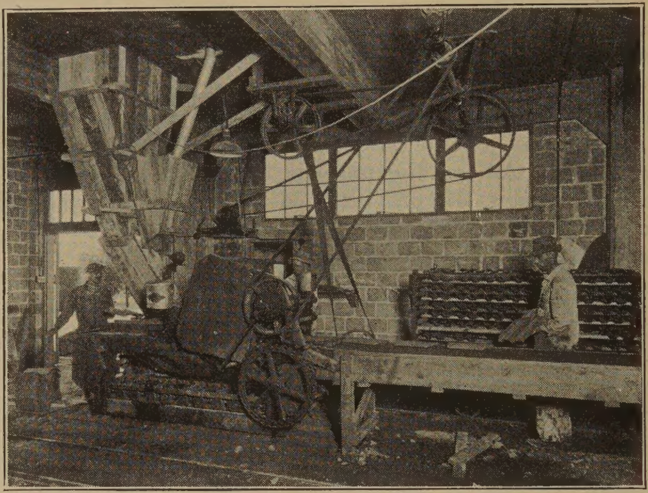
The traveling batcher which proportions the materials by weight. The operator is dumping a measured batch into the mixer

As previously mentioned, three types of aggregate are used—a coarse sand, limestone from ½- to ¼-in. and limestone from ¼-in. to dust. Experiments have shown that very satisfactory results are obtained when 600 lbs. of sand, 375 lbs. of coarse rock and 300 lbs. of fine rock are used. This gives a total weight per batch of 1275 lbs. to which 2 bags of cement are added. By volumetric measurement the proportions used would be approximately 1 part of cement to 6 parts of combined aggregate. The principal reason for weighing the aggregates is to get away from the bulking effect of moisture. Our experience has shown that we can weigh to within a pound or two and that an unusually uniform number of units are produced per batch.

Cement is received on the railroad siding and placed on a sack elevator which takes it to a table near the mixer where the cement is added to the batch. Storage space is provided for cement on the second floor close to the mixer.

The mixing is all done on the second floor. The mixer is located directly over the Duntile machines and discharges directly into steel hoppers feeding the machines. The company operates two Duntile machines and has recently installed a power-operated Brock roofing tile machine which makes Spanish and French roof tile.

The work floor is laid out with transfer tracks at the front and rear of both the tile machines so that empty trucks may be pushed in from one end and loaded trucks taken out from the other. The tracks alongside the machines are long enough to carry three trucks—one filled, one being filled and the other empty. This permits the machine operators to work without interruption, one man being required to push loaded trucks into the curing rooms and to get the empties in place. Roofing tile is carried from the machine on a belt conveyor from which it is taken by the off-bearers and placed on the trucks.



The roofing tile machine

The curing rooms are located at the back of the plant. They are covered with a concrete slab which forms the floor for a 40-ft. clear span room used for making roofing tile specials. Each curing chamber contains two lines of tracks.

Fourteen men are required to operate the plant, which has a capacity of approximately 4000 8- by 8- by 12-in. tile and 50 squares of roofing tile per 8-hour day. The distribution of labor, at capacity operation, is as follows:

1 man mixing and proportioning for both the Duntile and roofing tile machines.
2 men feeding each Duntile machine.
2 men strippers and off-bearers on each Duntile machine.
1 man roof tile machine operator.
1 man feeding pallets for roofing tile.
2 men off-bearers on roofing tile machines. These men spend about half their time on yard work.
1 man making roof tile specials.
4 men in the yard. They also handle the trucks from machine to curing rooms.
—
14 men—Total.

Ordinarily five men are required to operate a Duntile machine producing 2000 units per day—a production of 400 units per man per day.

Merchandising

The company has adopted an aggressive merchandising policy. At least one man is continuously in the field selling the products and this sales effort is backed up by newspaper advertising and direct-by-mail literature.

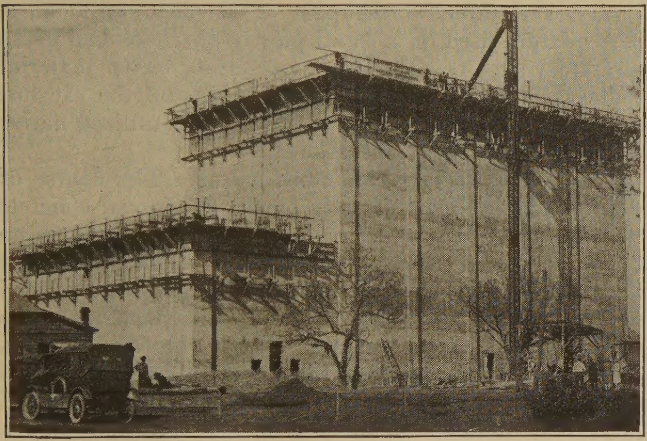
We have found that the use of color on concrete building units, as provided by the Duntile glazing process, has been a distinct selling help. Colored units are attractive and we have sold tile for many homes in which the glazed concrete units were used for the entire building. These units have been used principally for above grade work.

Carl Williams is president of the Kansas City Duntile Co.; J. L. Strandberg is vice-president, and the writer is secretary and manager.

Ice Storage Vault

The accompanying photograph shows work nearing completion on the reinforced concrete storage vault built at Nashville, Arkansas. Using 4-ft. slip forms, work was completed in 222 hours.

The all-season or permanent storage consists of two 10-in. walls with a 12-in. air space for cork insulation. Outside dimensions are, length, 106 ft., width, 66 ft. and height, 76½ ft.



The outside dimensions of the daily storage are, length 82 ft., width, 39 ft., and height, 36 ft. There is a 15-in. air space for cotton seed hulls. The floor is composed of 6 in. of concrete, 4 in. of cork, and a 4-in. top finish.

The storage was built for the Southern Ice and Utilities Company by the E. W. Sproul Construction Company. Max Gottschalk was the superintendent and Hugo Layer the architect.

New Books

Estimating Building Costs, by William Arthur. Published by the Scientific Book Corp.

This is the third edition of this useful little book, and there is no reason to suppose that it will not be quite as popular in this edition as it has been previously.

This is primarily a book for the man who is called upon to estimate the cost of structures of small or moderate size. For such men it is doubtful if anything more convenient could be devised. It does not touch upon the larger type of business and industrial structures, however, and contractors handling such work will not find it particularly helpful. Men doing residence work and small stores, shops, etc., however, will find the book most helpful. The items covered include everything from excavation to painting.

On Structural Design

The Theory of Structures. By Charles M. Spofford, S. B. Third Edition Revised and Enlarged. (Published by McGraw-Hill Book Co., Inc.)

When an engineering text reaches its third edition, there ordinarily remains but little to be said regarding it that has not already been said before. This book, however, is an up-to-date and complete text on the general theories underlying structural design, and in its present form it is not only suited to the requirements of students, but makes a convenient reference volume in the library of the practicing engineer as well.

No particular type of construction receives preferred attention in this text. It is devoted rather to those underlying principles which govern all good structural design than to the exploitation of any special types.

Estimating Materials

Tables of Quantities of Materials for Concrete. Published by the National Sand and Gravel Association, Inc., Washington, D. C.

In this publication, known as Bulletin 4, information on quantities of materials required for concrete is presented in a somewhat different manner than is usual. From it, quantities of cement and fine and coarse aggregate per cubic yard of concrete may be determined for a wide range of proportions, consistency, and grading of aggregate.

Fundamental factors affecting the volume of concrete, such as the volume of solids in the cement and aggregate and the volume of mixing water are taken account of. Computations are made for a variety of ten mixes, including the arbitrary proportions. Each table covers the range in quantity of mixing water likely to be required for proper conditions of workability and a wide range of aggregates.

The quantities given are calculated by the method outlined in Bulletin 1, "Estimating Quantities of Materials for Concrete," published by the same organization.

Special Aggregates

Slag, Coke Breeze, and Clinker as Aggregates, by F. M. Lea and F. L. Brady. Special report No. 10 on building research issued by the Department of Scientific and Industrial Research. A British government publication.

This report, while not absolutely final in its conclusions, contains a great deal of information that should be in the hands of those who are using or planning to use special aggregates. It does not contain much new information, but it does bring together in convenient form practically everything that is known today regarding the suitability of cinders, slag, and other special aggregates of that nature.

Sawdust as Concrete Aggregate

A Study of the Use of Sawdust in Concrete—Some Early Uses—Recent Jobs in Which Sawdust Was Used as Aggregate—European Uses—Tests—Mineralized Sawdust—Nailability—Strength and Fire Tests—Use Not Patented—Volume Changes in Sawdust Concrete—A Possible Light-Weight Nailable Aggregate for Concrete Block and Tile

THE article on page 39 of the June, 1928, issue of CONCRETE, describing certain British tests of the value of cement-and-sawdust building block, again brings to mind the commercial development of the use of sawdust in various forms of concrete.

Commercial uses of sawdust are not confined to mortar coats or building blocks alone. It is also true that efforts to utilize this product date back much further than many of us realize. For many years men with imaginations have sought ways to find commercial uses for the growing piles of sawdust accumulating at every saw-mill. It was a by-product that challenged men to find some way to take advantage of its possibilities beyond its use in foot paths, for which it had no commercial value.

When this writer was a small boy his father owned a water pail that was made of compressed sawdust, held together by some cementing substance. One day a horse stepped into the pail and ended its usefulness; but even then, in the nineties, the pail had seen many years of service. The writer does not know where this pail came from or who made it; but its existence proves that efforts were made to find a commercial place for sawdust long before the days of modern industrial development.

Early Uses

As long ago as 1896 the report of the chief of engineers of the U. S. Army described a series of tests made under the direction of Lieut-Col. Lydecker to determine the effect of mixing sawdust with portland cement mortars. As would be expected, the strength decreased as the proportion of sawdust increased.

Another early reference occurs in "Cement and Concrete," edition of 1907, a well-known textbook of its time. The author, L. C. Sabin, was an assistant engineer in the engineer department of the U. S. Army. On page 273 he refers to the use of sawdust in mortar "where a light and porous mortar is desired for use in floors and similar purposes." A table contains the result of tests of the effect of various proportions of sawdust from white pine added to cement-and-sand mortar, or to neat cement mortar. The tests made consisted of tensile tests of briquettes. No reference is made to the ability of such mortar to hold nails, indicating that this quality was either not known or not appreciated.

Nailability

A few years later, however, the ability of this mortar to hold nails had attracted the attention of architects. Edward L. Tilton, a New York architect, specified a mixture of sawdust, sand and cement for the nailable subfloor in the public library in Springfield, Mass., where 5,000 sq. yds. of the material were placed in the summer of 1910. A similar sub-floor was placed about the same time in the Connecticut State Library building in Hartford, Conn.

The sub-floor in the Springfield library was placed after experiments were made with variously proportioned mixtures molded into sample slabs. The proportions finally decided upon consisted of one part of cement, two parts of sand and three-fourths part of sawdust, although a 1:2:1 mixture used on a small part of the floor had given satisfactory results. The sand was clean, sharp material produced in the vicinity of Springfield, and the sawdust was obtained from a local box factory that utilized native pine wood, much of it unseasoned.

The sub-floor construction consisted of a 2-in. course of cinder concrete placed directly on the reinforced concrete floor slab, and a 1-in. layer of the sawdust mixture on top of the cinder concrete course. The sand-and-sawdust coat was finished by a steel-faced straight-edge guided by 1-in. by 2-in. screeds. The floor was then given its final covering of cork carpet, nailed to the sawdust coat. The nails could be driven without difficulty, but they had good holding power, equal to that of the general run of commercial timber used in building construction. At the time the cork carpet was placed, four months after the sand-and-sawdust mixture was laid, no cracks had developed. The placing of this sub-floor attracted considerable attention from the technical and trade press.

In the meantime, investigators in England, France, Germany and elsewhere were carrying on experiments and finding uses for sawdust in cement mortar mixtures. As in this country, the mixtures were first tried out in subfloors; but soon the material was under investigation to determine its possibilities in the manufacture of floor tile, partition block and roofing tile.

Mineralized Sawdust

Serious attention then was given to the chemical treatment of sawdust for the purpose of "mineralizing" it. The process, which was developed in England and was patented, rendered the material incombustible and eliminated much of the expansion or shrinkage that accompany changes in the moisture content of wood. The chemical used in the treatment is believed to be a calcium chloride solution, inasmuch as this chemical is named in British patent No. 180,887, taken out as of May 19, 1921. It appears that a solution of sodium silicate produces similar results. This treated product is in the market in the United States, in Canada and in England. The mineralizing process makes it possible to use the treated sawdust as the only aggregate, the addition of sand being unnecessary.

In England mineralized sawdust concrete has been used in sidewalk construction, in wearing surfaces of floors and in the manufacture of hollow partition tile, roofing tile and precast lumber. For these purposes the proportions vary through a range extending from two to five parts of treated sawdust to one part of portland cement, the richer mixtures naturally being the ones employed in sidewalks, floor finishes and other locations where resistance to abrasion is an important factor. Quietness and resiliency are among the qualities claimed for floors and walks built or finished with this material.

A sidewalk in which the mixture was one part of portland cement and two parts of treated sawdust was laid in St. Pancras, London, England, in 1922, and is said to have given satisfactory service. Roofing slabs of similar material were used in 1925 on the new buildings of the Canadian International Paper Company, at Three Rivers, Quebec.

Columbia University Tests

In the period from November, 1923, to July, 1924, the company that promotes the process of mineralizing sawdust had a number of tests made at Columbia University, in New York, and also in England. These tests were made to determine the various mixtures required to obtain desired tensile and compressive strengths and other qualities. Much better results were obtained with coarse sawdust than with sawdust containing a large proportion of "wood flour." The Columbia University tests for compressive strength indicated the following average values for 1:2 mixtures of portland cement and treated sawdust.

Age of Specimen	Compressive Strength in Lbs. per Sq. In.
7 days	1,030
28 days	1,540

Absorption tests made in accordance with the American Concrete Institute specifications for concrete masonry units disclosed values ranging from 4.6 per cent, by weight, up to 17 per cent. The low percentages were, of course, obtained with the rich mixtures.

Abrasion and permeability tests indicated satisfactory qualities in these respects; and rather extensive fire tests of partition block of mineralized sawdust gave quite favorable results in comparison with similar tests of gypsum block partitions. Detailed reports on these tests can be obtained by addressing the Department of Civil Engineering, Columbia University, New York City.

As pointed out in the article on page 39 of the June issue of CONCRETE, more recent tests and investigations conducted by the Building Research Board of the Department of Scientific and Industrial Research of the British Board of Trade have supported many of the claims made in behalf of mineralized sawdust. Unfortunately, one important exception must be recorded, namely, that shrinkage and expansion due to changes in moisture content have not been eliminated to a sufficient extent. Until this is accomplished mineralized sawdust concrete, whether in monolithic or block form, cannot safely be used where it is exposed to atmospheric conditions.

The tendency to shrink or expand with the decrease or increase of moisture content is of no importance where sawdust is used as an aggregate in partition block, in back-up block, in sub-floors, and in all other locations not exposed to moisture. This statement applies to mixtures of raw sawdust with sand and cement no less than where mineralized sawdust alone is used with cement.

In view of the fact that the mixture of raw sawdust and sand is not patented, the possibilities of its development as a side-line are worth the attention of block manufacturers. Sawdust obtained from a local saw-mill and mixed with sand and cement produces a low-cost partition block or back-up tile that will take plaster direct and will take nails without cracking. Actual proportions should be determined by experimenting with the materials at hand; but a good mixture to start with in making such experiments will be one part of cement, two parts of sand and one part of sawdust.

June Construction High; Raises Year to New Level

In refutal of predictions to the contrary, the total volume of all types of construction work handled during the first half of this year amounts to a figure substantially above that for the same period of 1927, according to statistics just compiled by the Associated General Contractors of America. June, 1928, in fact, witnessed the greatest volume of work ever carried on in the United States during a single month.

June construction contracts in the 37 states east of the Rocky Mountains surpassed all previous June records, the F. W. Dodge Corporation reports. This was, however, according to the Dodge corporation, the second highest monthly total on record. This latter report reiterates that of the A. G. C. that the total amount of new construction work since the first of the year is the greatest on record. The Associated Contractors' statistics are based on shipments of construction material and those of the Dodge corporation on contracts awarded.

The A. G. C. figures show that last month's volume was 32 per cent greater than the total recorded for May and 15 per cent greater than the figure registered for June of last year. The increase over the May total was the greatest ever to be recorded during the period of one month.

Indications are that the mid-summer months will not see a slackening of the rapid pace set during recent weeks. The volume of contracts awarded during the first five months of this year exceeded the total for the corresponding period of 1927 by 12 per cent.

Five Cities Adopt Shreveport Building Code

Shreveport, Louisiana, with a population of about 80,000 and an annual construction volume of around four million dollars, was the first city east of the Rocky Mountains to adopt the proposed uniform building code for Pacific Coast cities. The new code was adopted on February 28th of this year.

As one result, this enterprising Louisiana city appears to have blazed the way for others, for no less than five neighboring cities, all rapidly growing communities, have adopted the Shreveport draft. The cities referred to are Meridian, Miss., Monroe, La., Beaumont and Port Arthur, Tex., and Eldorado, Ark. Several larger cities have the Shreveport code under consideration, but have not as yet taken legal action toward actual adoption of the code.

While the Shreveport committee which had the work in charge made some modifications to meet the requirements of local ordinances and state laws, the code follows the general arrangement and text of the Pacific Coast document. It follows more faithfully the exact wording of the recommendations of the Department of Commerce Building Code Committee, and it reduces the rather excessive height to which combustible construction is sanctioned in the Pacific Coast code.

The adoption of the Shreveport draft by these other cities provides additional evidence of the interest in uniformity for building regulations.

Portable Mixer Used in Remodeled Products Plant

Sidney Crew Remodels His Concrete Products Plant at Cincinnati—Portable Mixer Permits Accurate Proportioning—Ingenious Device for Controlling Water Content

THE progress being made in the design of concrete products plants is well illustrated in the new plant of the Crew Builders Supply Company at Norwood, Cincinnati, Ohio. This is one of the oldest plants in the country, having been founded by Sydney I. Crew some 22 years ago in the very infancy of the industry. From a start at that time with the usual hand mold and tampers making a 12-in. block 32 in. long, it has steadily grown until today it represents the most modern type of plant to be seen anywhere in the country.

Material Supply

Along with the growth seen here in the concrete products field, Mr. Crew has built up one of the leading builders supply houses in this vicinity. Some two years ago a sand and gravel tipple to supply concrete aggregate was added to the equipment with the thought in mind at that time that this would eventually also supply the material for the block plant. Also, at that time a plant to manufacture ready-mixed brick mortar and plaster was built with the necessary bins for those materials. From the dump pit in the railroad siding, the material is elevated and then by-passed to either the concrete storage tipple or to the mortar bins.

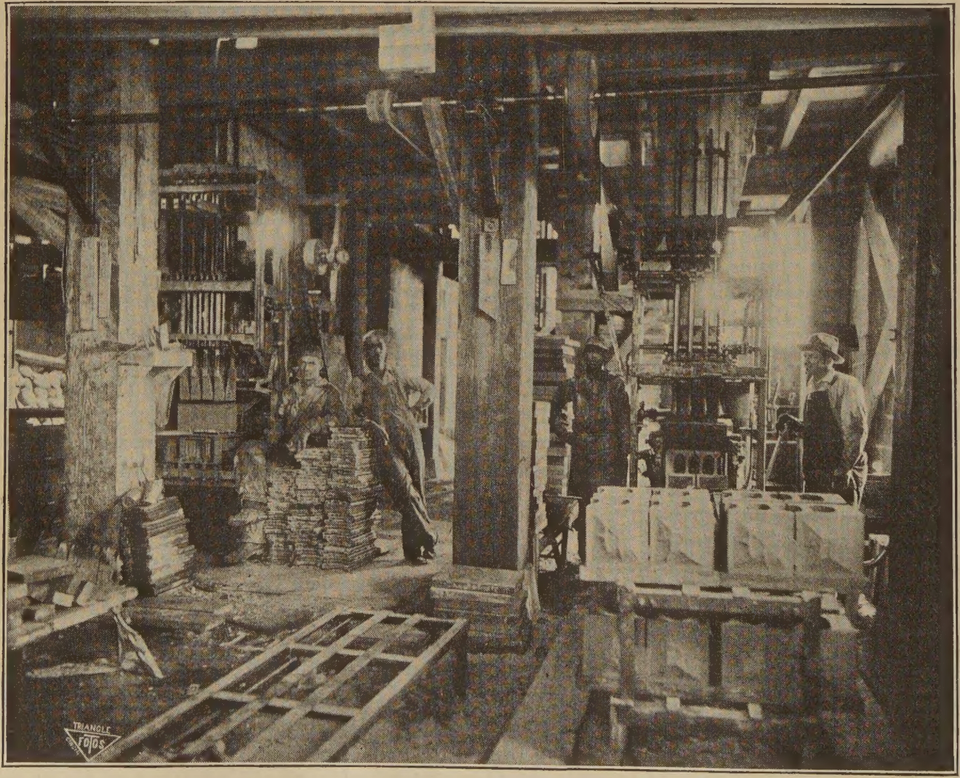
Mixing and Machine Floor Levels

The first of the present year the new block plant was started which has another belt conveyor to bring the sand and gravel from the belt supplying the concrete tipple to the new block bins. These were built high enough so that two levels—a mixing floor and the machine floor—could be built below them. Everything is fed by gravity from the bins to the machines.

Portable Mixer Used

On the mixing floor a portable 2-bag mixer mounted on a track is used. This may be placed under any one of five batchers, each with its separate bin. This enables the mix to be graded to any desired fineness modulus and once set it insures very great uniformity in the batches.

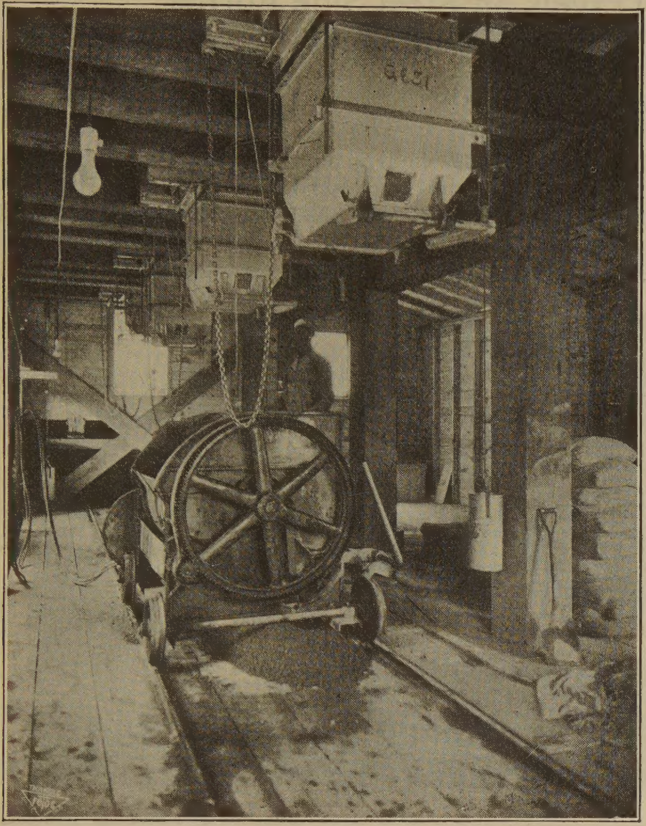
A water measuring device of unique design was recently added. A 12-gallon copper wash boiler had a toilet valve fitted of the type that insures proper closing and instant discharge. The amount of water used is varied by adding to or subtracting from the volume below the float, of one quart concrete cylinders. In this manner not only is the water kept uniform but the amount used per sack of cement is known at all times. The capacity of the 2-sack



The block machine floor. The plant is so designed that the materials move by gravity from the bins through the mixer into the machines mixer enables the operator to allow the concrete to mix for at least 5 minutes before dumping.

Each machine has its separate hopper into which the batch is dumped. No handling of aggregate or water is required until the product is taken from the machine.

Two new machines were purchased by Mr. Crew for this new plant. An Abrams Blue Ribbon and the latest type double-bar Anchor tamper. The Anchor tamper is designed for 50 per cent cores to lighten the weight of the product for above ground use, using the material thus saved to make better concrete in the net section.



The portable mixer may be moved under each of the five batchers, making it possible to combine the aggregate for any desired grading

The final step, that of curing, is done in steam dry kilns which were built at the time of the mortar plant with the new block plant in mind.

British Research Board Investigating Artificial Aggregates

The Building Research Board connected with the British Board of Trade's Department of Scientific and Industrial Research has for a considerable time experimented with the use of artificial products as aggregate. Pending the completion of its present experiments, the department has recently issued a report by F. M. Lea and F. L. Brady on the present general position of slags, coke breeze and clinker as aggregates. This report does not purport to give new results, but contains a general account of these substances and indicates many of the troubles to be avoided in their use as cement aggregates. The experiments now in progress at the Building Research Boards' station deal especially with the unexplained variations in the properties of clinker and similar materials when used as aggregates.

Roughly one and one-half tons of slag are formed for every ton of pig iron made. Slag dissolves large volumes of gases, and when these are given off, on cooling, the material is porous, and, in addition to being of a lower density than natural aggregates, the porous structure forms a good key between aggregate and cement. The slag may be air cooled and, so supplied in lumps, or granulated, or converted into slag sand by cooling it very rapidly with water. Its density is very variable, and depends largely on the extent of voids left in it.

The experiments have shown that both acid and basic slags can be employed satisfactorily, and at present the best chemical indication as to their suitability is that they should not be too highly acid, which is apt to give them a glassy fracture and too high a resistance to the binding action of the water contained in concrete. Nor should they be too highly basic, for this is liable to cause disintegration after they have set. Employed, however, with good judgment, according to the indications given in this report, they have been found eminently satisfactory, especially if the extremely fine particles are removed and replaced by sand.

The word "breeze" is used rather loosely to indicate materials of varying origin and composition. Coke breeze, however, is strictly the small coke produced by coke ovens of gas works. Also, pan breeze is the residue obtained from a coke which has been used as a fuel and after passing through the furnace has fallen into the pan. It is about 40 per cent higher in density than coke breeze. Clinker consists of furnace ashes from which, in the process of combustion, almost all the combustible has been removed. Therefore it does not include ashes from open domestic fires and the like, which contain much unburnt material, and have not sufficient strength to be used satisfactorily as aggregates. The specific gravities generally lie between 1.02 and 1.09 for large coke breeze, and between 1.21 to 1.38 for fine coke breeze (all through a ¼-inch square mesh, the corresponding figures for pan breeze being 1.38 to 1.40 and 1.43 to 1.50). Clinkers have a specific gravity of about 1.47 with 1.80 for anthracite clinker.

A number of impurities in clinker and breeze that are already known to make them unsuitable for use as an aggregate are described in the report. These impurities usually have a low conductivity and, so far as clinker is concerned, a good resistance to fire. Some clinkers are particularly suitable for the manufacture of lime mortar and plaster due to the puzzolanic properties.

On the whole, information collected in the report appears to show that a concrete can be made from slag with a strength equally as high as that of gravel concrete, and frequently higher. Furthermore, it serves usually in association with pumice, as an aggregate in special sound-absorbent plasters. Like that of breeze concrete, its strength may often be improved by using sand as fine aggregate instead of slag fines or granulated slag.

Clinker produces concrete with a lower strength than gravel concrete, but with a greater strength than breeze concrete. On the other hand, coke breeze concrete is usually of lower strength and unsuitable for outside or wet situations. It possesses, however, the extremely important advantage of yielding a light product which can be used for internal walls. All these materials require careful selection according to the purpose for which they are to be used.

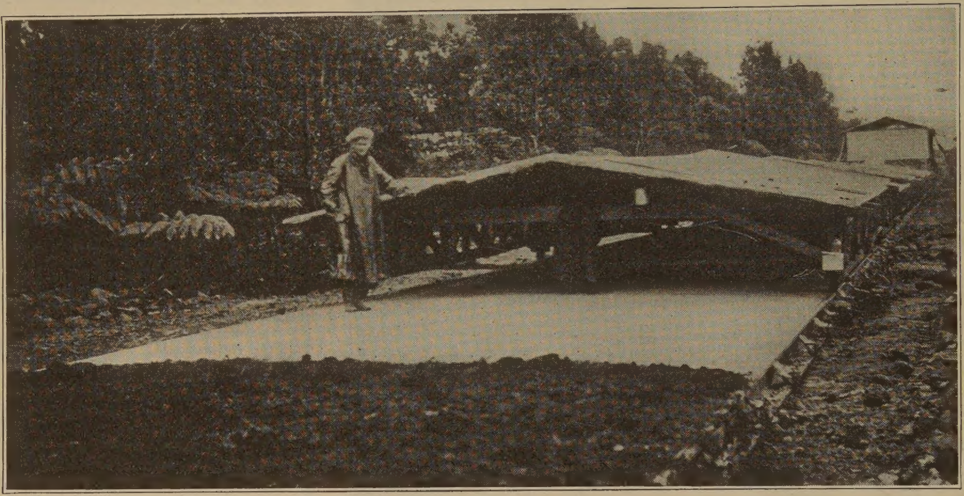
It is hoped that the investigations which the Building Research Board now has in progress with regard to clinker may produce definite scientific data concerning the substances that are dangerous when it is used as an aggregate, the general conditions that accelerate or retard the action of these substances, and some simple means of testing the clinkers.

Traveling Shed Trains Shelter Both Workers and Fresh Concrete from Tropical Rains

Device Invented by Road Builder Protects Workers and Machinery from Elements—Travels on Steel Side Forms —Hauled by Cables Attached to Paver

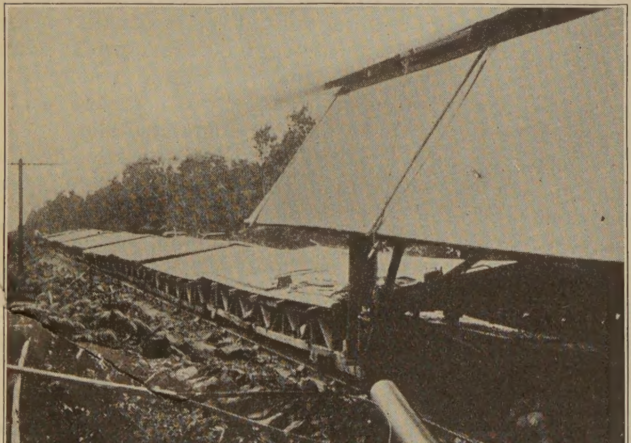
By N. C. McLOUD

TRAVELING sheds have been devised by a road builder in Hawaii to protect his workers and machinery from the daily tropical rains which prevail at some seasons. The first of these outfits was used on the 30-mile stretch of road which completed the highway between Hilo and Kilauea Crater.



Rear view of the traveling sheds, showing how the outfit moves along the side forms. The workshed is in the background.

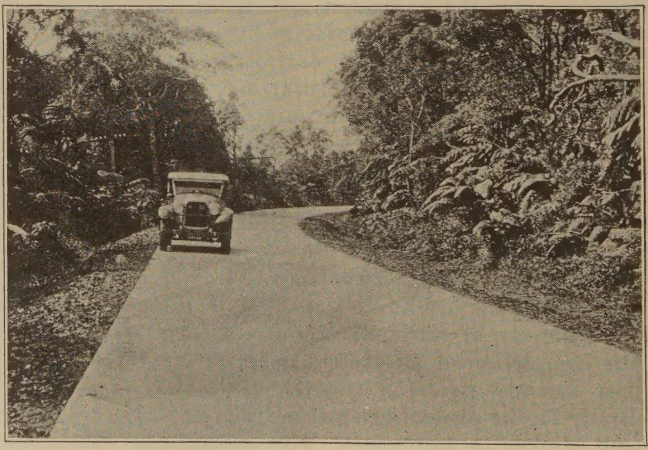
The sheds are mounted in flanged wheels which travel on the steel side forms provided for the support of the concrete pavement at the edges. The main "traveler" is 16 ft. high in the clear and 50 ft. in length, and is equipped with awnings on three sides for added protection against wind and driving rains. This structure houses the paver and finisher during the actual work of construction and shelters the workmen.



At this point the grade was 6 per cent, permitting moving the train by gravity.

Coupled to the main shed, and following it on the rails are 10 lower protective sheds to protect the green concrete until it has hardened sufficiently to withstand the pitting effect of the heavy downpours. Half of the "trailers" are 2½ ft. high and alternate units are six inches higher, to permit overlapping roofs. Each shed is 30 ft. long.

As the work progresses the 350-ft. "train" moves forward, hauled by means of cables attached to the paving machine. On downgrades the movement is by gravity.



Showing a turn in the road from Hilo to Kilauea crater

The sheds enable the contractors to proceed without loss of time, as shown by the experience on the Hilo-Kilauea road, when daily tropical downpours caused no interruption to the work.

Simplified Practice in Concrete Industry

How Simplified Practice Has Helped the Concrete Contractor, the Designer and the Products Manufacturer—Effect of Saving $11,500 Annually for One Products Manufacturer—Building Units, Reinforcing Bar and Metal Form Sizes Standardized

By S. F. TILLMAN
Division of Simplified Practice, Department of Commerce

The Department of Commerce, under the direction of Herbert Hoover, has done much for American industries. One of the important phases of this work is that coming under the Division of Simplified Practice.

How the concrete industry was benefited through the work of this body is shown in the following article, written especially for "Concrete" by S. F. Tillman.

OF the more than 90 simplified practice recommendations that have so far been promulgated by industry under the auspices of the Division of Simplified Practice of the Department of Commerce, there are four that are of especial interest to the concrete industry. Each recommendation, as it is promulgated, is numbered in chronological order.

The four recommendations are as follows: S. P. R. No. 26, Steel Reinforcing Bars, Cross-Sectional Areas; S. P. R. No. 32, Concrete Building Units, (length, width and height of blocks, tile and brick); S. P. R. No. 53, Steel Reinforcing Spirals; and S. P. R. No. 87, Forms for Concrete Ribbed Floor Construction (widths). The eliminations under the recommendation follow:

			Reductions	
S.P.R.	Item	From	to	Percentage
26	Steel Reinforcing Bars	32	11	66
32	Concrete Building Units	115	14	88
53	Steel Reinforcing Spirals	7	4	43
87	Forms for Concrete Ribbed Floor Construction	7	2	71

At the time the recommendation is promulgated by the general conference a standing committee is appointed by the conference to insure the promotion and observance of the completed project. The membership of the committee is truly representative of all phases of the industry, since it consists of representative manufacturers, distributors and organized users of the specific commodity concerned. The usual custom of general conferences providing that the recommendation shall be subject to periodic surveys on the part of this committee, to review and make any recommendation with regard to modifications and revisions, safeguards the fullest development of individual initiative and invention as well as care for the changing trends of industry.

Annual audits, or re-surveys, conducted during the first quarter of 1928 by the standing committees of eight different recommendations revealed that there was an average degree of adherence of 89.18 per cent on the part of the acceptors to the respective simplification programs. It has been found that the general adoption of, and adherence to, simplified practice recommendations in this field, make possible economies in the manufacture of the commodities, which, passed on to the consumer, mean actual savings in costs of construction. During 1926 the standing committee for the Steel Reinforcing Bars recommendation reported an estimated degree of adherence of 80 per cent, while the standing committee for the Concrete Building Units recommendation reported for the same year that the average degree of adherence was 98 per cent, based on the results of a factual survey.

There has been a steady adherence gain yearly, which would indicate that simplification programs, when followed out to their natural conclusions, result in benefits to small and large manufacturing concerns alike, as well as to the distributors and ultimate consumers. Many reports have been received by the Division of Simplified Practice from acceptors of the recommendations giving approval to the elimination of unprofitable lines movement, and at the same time commenting on the individual benefits that have been derived.

Products Manufacturers Make Savings

To illustrate, a manufacturer of concrete building units reported savings of $11,500 per year, due to the simplification in his field, while another reported a saving of $500 in his office operations alone, and a third stated that he had been enabled to reduce the selling price of his commodity 25 per cent.

Simplified practice and standardization are rapidly gaining recognition as economic factors in business, helping to reduce the cost of manufacture of the commodity and the expense of distribution. It has been the experience of the Division of Simplified Practice that a "simplified" line of products makes the cost less to the ultimate consumer and makes for improved quality as well. If a distributor can cut his inventory by 75 per cent, and obtain better, quicker delivery from the producer, his gains are passed on to the consumer in the form of improved service, immediate replacement of stock, and a gradual reduction in cost of the item as the simplified practice recommendation comes into more general use.

Further evidence that simplified practice is proving of greater value to producers and purchasers is found in the rapidly increasing number of associations and individuals accepting the adopted projects. The list of associational acceptors increased from 686 to 815 during 1927, while the individual list grew from 2,775 to 7,731. The increase of individual acceptors is indicative of the fact that a greater number of commercial buyers are specifying the simplified lines when placing their orders, because they offer better quality, faster service, and not infrequently, lower prices.

Form Simplification

It will be of interest to know that eight new simplified practice recommendations were completed during the first quarter of 1928, with the total number of projects completed to date, as of June 1, being ninety. Included in the recommendations developed during this period was the one for Form Dimensions for Concrete Ribbed Floor Construction. (See page 35, May issue.)

In addition to the simplified practice recommendations that have been enumerated in this article, the concrete industry is also interested in the projects that have been promulgated for bank checks, warehouse forms, and the one for the simplified invoice form.

In referring to simplified practice as a program of elimination of waste, it might be well to clarify the meaning of the word "waste." In a restricted sense, the word "waste" means something perishable or something that cannot be utilized. There are, however, other wastes in industry, among them, those caused by too great diversity in manufacture. Because of this over-diversity, a part of every dollar spent is in payment for this waste.

The desire of some manufacturers to produce something different from their competitors often results in flooding the market with a surprising variety of articles which show only slight and immaterial differences in size and form. This practice has clogged avenues of distribution, congested the shelves of retailers and the warehouses of wholesalers. The correction of this condition, on the part of industry through the co-operative services of the Division of Simplified Practice, is done through simplified practice.

Northwest Products Meeting Proves Profitable to Members

By F. R. ZAUGG

What was probably its best meeting yet was held by the Northwest Concrete Products Association on July 16th and 17th, at Paradise Inn, at Rainier National Park.

The meeting opened the morning of the first day with a business session, at which time the association's new monthly leaflet, "The Precast Product" was made its official bulletin.

Advertising, according to the report of the committee in charge, had been temporarily discontinued, but following the provision of additional funds association advertising would be resumed.

An educational campaign on concrete culvert pipe was outlined and the legislative committee was instructed to see it through. The Culvert Pipe Committee recommended that definite wall thicknesses for concrete culverts be used, practically following the Joint Concrete Culvert Pipe Committee's recommendations. A rousing talk was delivered, also in the morning, by Rev. C. Oscar Johnson of Tacoma on "Man, Money and Morals."

The first afternoon's entire session was devoted to the concrete products sales conference conducted by W. D. M. Allan of the Portland Cement Association. Similar to others held nationally, it gave those products men in attendance a new light on the manufacture and especially on the sale of concrete products.

The second morning's session, including some excellent papers, opened with one entitled "Some Drain Tile Test Results Compared with Service and Specification Requirements" and presented by S. H. Graf. The substance of the paper showed variation in drain tile manufacture and recommended better grading and control in general in the manufacture of the product to insure greater satisfaction in its continued use.

G. W. Gleason, author of the next paper, "The Second Research Fellowship Progress Report," presented a study of the effect of acids and alkalies on concrete pipe, showing harmful results in extreme cases. In ordinary cases, especially on the Pacific Coast, however, the report stated, very little harm could possibly result from either to well cured, dense pipe.

The third paper of the day, "Concrete Pipe in Tacoma," by C. E. Putman, engineer for the city, condemned the poorly made concrete pipe of fifteen to twenty years ago in which some failures had resulted. Present-day pipe, he said, was considered excellent and his city would continue to use it to the extent of approximately 70 miles, in sizes from 6 to 84 inches, during the next two years.

"Results of Tests on Culvert Pipe," presented by Bailey Tremper, contained tabulated results of tests from 11 plants in the state of Washington conducted by the State Highway Department in co-operation with the Northwest products association. Improvements are likely to follow the adoption of the new specifications now being worked on.

R. P. Rogers and W. T. Wright, of the University of Washington, delivered a report showing results and relations established between crushing tests of cylinders and the crushing test or strength of concrete pipe when made of the same materials. Tests conducted on 4-, 6-, and 8-inch sizes only showed that a relationship existed that considerable more results from tests should first be had to draw any definite conclusions. The work was done under the direction of Prof. Ira T. Collier.

Following the passing of a resolution presented by E. B. Ballinger, Prof. S. H. Graf, director of engineering research of the Oregon State Agricultural College and Prof. Ira L. Collier of the Civil Engineering Department of the University of Washington were elected to honorary membership in the association.

The invitation of H. A. Hall of the Eugene Concrete Pipe Company to hold the next annual meeting at Eugene, Oregon, was accepted and the date set for January, 1929.

City Officials Organize as Division of American Road Builders

Capt. H. C. Whitehurst, assistant to the engineer commissioner of the District of Columbia, was elected president of the City Officials Division of the American Road Builders Association at the organization meeting on June 8th.

At the same time the division adopted a constitution and formulated plans for attaining the objectives for which it was organized. Chairmen of four major committees, as follows, were appointed: committee on administration and organization, Capt. Whitehurst; design and construction, George B. Sowers; maintenance, C. E. Myers, and on the committee on traffic, M. O. Eldridge.

In an address before the assembly, Col. R. Keith Compton, chairman of the Richmond, Va., Department of Public Works and president of the American Road Builders Association, told of the need for a city officials organization, stressing the aid it might render to cities.

In addition to the president, the following were elected as officers: secretary, Chas. M. Upham; treasurer, Jas. H. MacDonald; vice-presidents, C. E. Myers, Ben S. Davison, W. R. Hopkins, and John C. Shaw.

~ EDITORIAL ~

"Concrete for Permanence"

DAY by day, almost, the question of durability of concrete is becoming more important. Evidence of this is found in the subjects discussed at the last meeting of the American Society for Testing Materials, reported on other pages in this issue. We know now that it is possible to secure concrete of certain definite strengths. The factors influencing strength have been studied and tested till at present many of them are fairly well known. But we do not as yet have much definite information, supported by laboratory tests, on just what constitutes durability. It is, therefore, not surprising that attention is being shifted from strength to durability.

It is interesting to know that many of the principles that make for ***strong*** concrete also increase its ***durability.*** Prof. Scholer's tests, reported at the A. S. T. M. meeting, indicate that variations in the water-cement ratio have a very marked effect on durability. He finds that a water-cement ratio of 1.0 is near the maximum permissible for concrete in exposed situations—one example of the similarity between strength and durability factors.

Density is, perhaps, the most important requirement for durability. Concrete, as Prof. Scholer has shown, is particularly susceptible to freezing and thawing of entrapped water and to the movement of water through it. This feature, influenced as it is by many of the factors which we now know have a bearing on strength, can by itself almost be considered the measuring stick for durability.

Given impervious aggregates and a cement-water paste in which these aggregates are properly embedded and a long step toward density and therefore durability, has been taken.

Very few studies have been made and reported, aiming directly at a determination of factors affecting durability. Such studies as have been made show that when all the principles for making quality concrete as we now know it are followed, we can expect to come fairly close to securing durable concrete as well as strong concrete.

Much study must still be given to the subject of durability and the factors that influence it, but in the meanwhile we must follow rigidly the requirements we already know. By making quality concrete, we are approaching the ideal—durability with strength.

Reserves of Wealth

WE are so accustomed to think of wealth only as money in the bank, equipment, plant, and yard stocks, that we often entirely overlook another source of wealth just as real, though not as easily seen.

This is the vast store of available information about your business—information that will enable you to build a better concrete structure or a better concrete block for less money. Year after year investigators and students have added to this store of wealth. Your share of it—or all of it—is there for you, if you will only put forth the effort needed to make it yours.

"Factual Wealth," Dr. Hollis Godfrey of the Engineering Economics Foundation calls it. And it can be demonstrated that this wealth is as real as money in the bank, for it can be converted into money.

How? Simply by applying the new facts about making concrete that are being assembled and published in the technical press, in the proceedings of the organizations concerned with concrete, in the papers read at your conventions, in the reports of the research laboratories, etc.

Newer and better methods of working with concrete are continuously being discovered. If we use them by applying them to our own activities we benefit. Neglect them and our competitors benefit. It is not merely a matter of whether we benefit or not. Either ***we benefit*** or ***we lose.*** The unprogressive concretor will be and is worse off as a result of these discoveries because of the harder competition he must face from those who have adopted them.

This is an age of keen competition. We are in a buyers' market. And we must adjust ourselves to this fact. No discovery that improves the quality of concrete or reduces its cost can be ignored. Buyers of our services or products are critical. They buy closely both with respect to quality and price. They can do so, because the balance of power is with the buyer. To meet his demands, we must apply every advantage available — tap this store of "factual wealth" that is ours for the taking.

Concrete Floors for Residences

IT is not often that a practically new field opens up for an industry. And when it does, there are usually only a few men far-sighted enough to see it and to take advantage of it.

Such an opportunity is now awaiting progressive men in the concrete industry. And, as has been the case in the past, few men are taking advantage of it.

The opportunity lies in the construction of concrete first floors in residences. Here is almost a virgin field for the house contractor and for the concrete products manufacturer. Many of the objections to the use of concrete floors have been removed, but their very important advantages remain.

Their value from the point of view of fire safety and durability are well known. And they can be built for only 20 cents per square foot more than wood floors.

P. G. RILEY
President

P. G. RILEY
GENERAL CONTRACTOR

T. G. McGOVERN
General Supt.

~~701 Temple Street, Pittstown, N. Y.~~

Los Angeles

Dear Mac:

Listen, don't think I am spending all of my time loafing around on construction jobs. I am not. The fact is, I am getting onto this "playing" thing a little better, but gosh, you can't keep a criminal away from the scene of his crime.

I met up with a contractor out here not long ago. He is slated to join the unemployed of my class soon, as he has two sons he has been training to run the business. Well, anyway, we are buddies now. We swap yarns, play poker and visit each other's lockers and occasionally he takes me out to some of their jobs.

The other day we were on the job that had quit the footing stage and seemed to be running along sweet. It looked to me like a well organized job, but one machine seemed to be out of tune and I told my friend it looked to me like it would sour the whole job soon, and that was the hoist.

He said, "Old son, I believe you are right. That hoist looks like it was my last mistake, because the boys are going to manage the business very soon. They probably won't make any mistakes, eh, what?"

And then he went on, "I'm clear ahead of you on that hoist matter, because you think I was bargain hunting. Not so, old top, not so—that hoist looks to me like just misplaced confidence or maybe bad judgment or both. I listened to every hoist salesman I could call in. Believe me, boy, I mean I listened until my head was full of drums, clutches, bearings, etc., but you can't blame those men. Each man was naturally completely sold on his hoist and gave me all the stuff that was in him in the way of selling. The only thing is, that sometimes the best talker may have the worst machine. At any rate, all of this talk left me with a rather hazy idea that after all, a hoist was just a hoist nowadays, and forgetting my past hoist experience, I bought of the fellow who impressed me the most with his sincerity and his belief in his hoist.

"What's wrong with this picture? Sure, I know, and damnitall, why I did this after all my years of experience gets me, but I guess we all do it. Do you know what, no machine should be bought in a hurry and it certainly should not be bought in an office. Every machine should be watched doing its stuff on some job, as near like the one you have for it to do as possible. In other words, each machine competing to you for adoption should sell itself to you away from the charming presence of personalities and far from the beguiling words of its loving friends and further still, from a price list. Say you not so, my friend? But let's leave trouble up to the boys to worry over and go over to the club," says he.

Yes, Mac, I am a club member now. The old man isn't so slow after all. But about this buying thing, Mac, it isn't always the best show that has the loudest ballyhoo, and as my friend found out, every hoist isn't a hoist. You wouldn't go out and just say, I want to buy a coupe. A Ford coupe is a coupe, so is a Cadillac coupe a coupe. It's a good idea to figure out carefully just what you want and need and pay the price necessary to get it, don't you think so, Mac?

Sincerely yours,

P.G.

This is the fourth letter of a group whose publication began in the May issue of CONCRETE *written by P. G. Riley, retired contractor, to his superintendent, Tom McGovern, back home. "P. G." is taking his ease in California and the distant fields, where he was once so active himself, look mighty green now.*

Perhaps his greatest pleasure is in keeping in touch with his superintendent and, off and on, his secretary, Anna Ryan. His being away from the scene of activity has given P. G. some new viewpoints and he manages, in his letters, to convey to the young folks some of the ideas in the back of his head. One of the bits of advice he has already given "Mac" concerned the wisdom of investigating operating performance when buying equipment. At another time he told Mac of the "catch" in the seemingly attractive trade-in offer. There's a lesson, too, he said recently, in not letting old, inefficient equipment eat up the profits.

Reinforced Concrete Design Simplified

Chart D-2—Unit Bond Stress

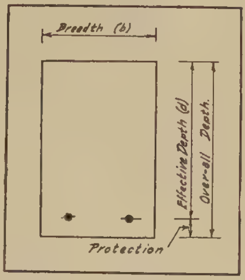
By PROF. JAMES R. GRIFFITH
Armour Institute of Technology; Assoc. M., A. S. C. E.

Joint Committee Specifications

$f'_c = 2{,}000$ lbs. per sq. in.
$f_c = 800$ lbs. per sq. in.
$f_s = 18{,}000$ lbs. per sq. in.
$n = 15$

$$u = \frac{V}{\Sigma ojd}$$
$$j = 7/8$$

Plain bars, Maximum $u = 80$ lbs. per sq. in.
Deformed bars, Max. $u = 100$ lbs. per sq. in.



THIS chart was not included in the original announcement but has been added at the request of a few designers who thought it a valuable addition to the series. It will be noted that the equation for obtaining the unit bond stress (u) is similar to that used in the July issue for obtaining the unit shear (v). The only new variable is the sum of the perimeters of bars in the set (Σo), replacing (b) of Eq. 1-D-1.

Chart D-2 Application

In the July issue, the end shear was determined for the problem solved in the May issue. The results so far determined for this problem are:

Breadth of beam (b) = 16 in.
Effective depth (d) = 25 in.
Overall depth = 27 in.
Area of steel (A_s) = 3.55 sq. in.
End shear (V) = 18,000 lbs.

Referring to Chart C, June issue, with this area of steel ($A_s = 3.55$), it will be seen that five 1-in. round bars meet the requirements for area. The scales of Chart D-2 have been lettered in pairs to indicate the order of solution. Isopleth (1) has been drawn between the values ($V = 18{,}000$ lbs.) and ($d = 25$ in.) on the *A-A* scales. Isopleth (2) has been drawn between a (1-in. round bar) and (5 bars) on the *B-B* scales. Isopleth (3) has been drawn through the intersection of isopleth (2) with the left (C) scale, and the intersection of isopleth (1) with the support. Isopleth (3), when extended to the right (C) scale gives a value in bond of ($u = 52$ lbs. per sq. in.).

The perimeter of a 1-in. round bar is 3.1416 in. By formula the unit bond is

$$u = \frac{V}{\Sigma ojd} = \frac{18{,}000}{5(3.1416)\,\frac{7}{8}\,25} = 52.3 \text{ lbs. per sq. in.}$$

Joint Committee Specifications

The Joint Committee Specifications under "Bond and Anchorage" discuss two types of bond stress. The first, involving shear and solved by Chart D-2, is given:

> "Where bar reinforcement is used to resist tensile stresses developed by beam action, the bond stress shall be taken as not less than that computed by the formula
>
> $$u = \frac{V}{\Sigma ojd} \qquad \text{Eq. 1-D-2}$$
>
> u = permissible bond stress = $0.04\ f'_c$ for plain and $0.05\ f'_c$ for deformed bars.
> V = total shear at section.
> Σo = sum of perimeters of bars in set.
> d = effective depth of beam.
> j = usually considered as 7/8.
>
> For continuous or restrained members, the critical section for bond for the positive reinforcement shall be assumed to be at the point of inflection; that for the negative reinforcement shall be assumed to be at the face of the support, and at the point of inflection."

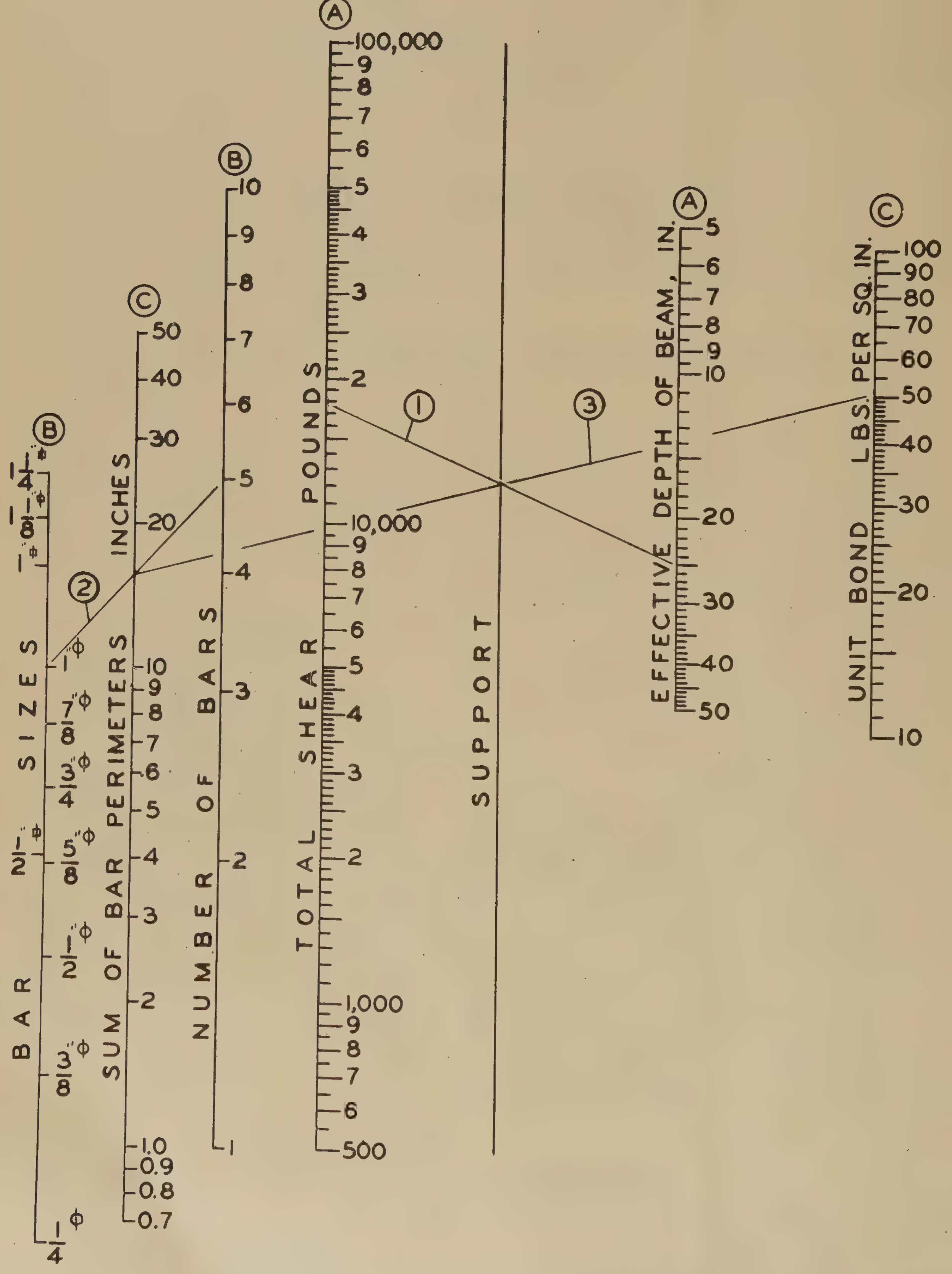
In the problem considered, the unit bond stress was found to be ($u = 52$ lbs. per sq. in.). This value was less than the maximum allowed for plain bars ($u = 0.04\ f'_c = 0.04 \times 2000 = 80$ lbs. per sq. in.). So plain bars would meet the requirements for bond. If the unit bond had been between the values 80 and 100, deformed bars would have been necessary since the maximum allowed for deformed bars is ($u = 0.05\ f'_c = 0.05 \times 2000 = 100$ lbs. per sq. in.). Chart D-2 shows the unit bond stress up to 100 lbs. per sq. in., the maximum permitted for deformed bars. If the results had indicated a bond stress higher than that shown on the scale, some other combination of bars, a larger number of smaller ones, would have been required. Under such circumstances isopleth (1) remains fixed with isopleths (2) and (3) changed for the new assumption.

Anchorage

The second type of bond stress considered comes under the classification of anchorage. The steel reinforcement

CHART D-2

Unit Bond Stress $u = \dfrac{V}{\Sigma o j d}$



This chart is based on the Joint Committee specifications. Designers using the new American Concrete Institute specifications can design similar charts from instructions given in the March, 1928, installment and in this article being in stress must have sufficient anchorage on either side of any section to develop the stress at that section. In other words, there cannot be a force without an equal and opposite reaction. Thus, at the end of restrained beams the steel reinforcement is figured as being stressed to withstand a moment. If that steel is not anchored sufficiently, the stress cannot be developed for the steel will pull out. The same condition exists where bars are to be spliced. The perimeter of a round bar is (πD), where (D) is the bar diameter. The area, or surface, in contact with the concrete for any length (L) is then $(L\pi D)$. For any unit bond stress, the total holding power for this length is $(uL\pi D)$. This total holding power must be equal to the total pull of the bar which is the product of the unit steel stress (f_s) and the area of the bar $\left(\pi \frac{D^2}{4} f_s\right)$. Now we can equate the total holding power to the total pull

$$uL\pi D = \frac{\pi D^2}{4} f_s$$

Now solving for the length necessary we get

$$L = \frac{f_s D}{u4} \tag{Eq. 2-D-2}$$

If the maximum steel stress $(f_s = 18{,}000)$ and the allowable bond stress for plain bars $(u = 80)$ are substituted in Eq. 2-D-2, we get

$$L = \frac{18{,}000\,D}{80 \times 4} = 56.2\,D$$

Thus for the allowable stresses herein considered, it can be said that 57 diameters will give sufficient bond, or anchorage for plain bars. Likewise, the necessary anchorage for deformed bars is

$$L = \frac{18{,}000\,D}{100 \times 4} = 45\,D$$

The steel stress (f_s) may be less than the maximum, thereby requiring less length for adequate anchorage, but usually the maximum length is provided. The Joint Committee specifies "The length of bar added for anchorage may be either straight or bent. The radius of bend shall not be less than four bar diameters."

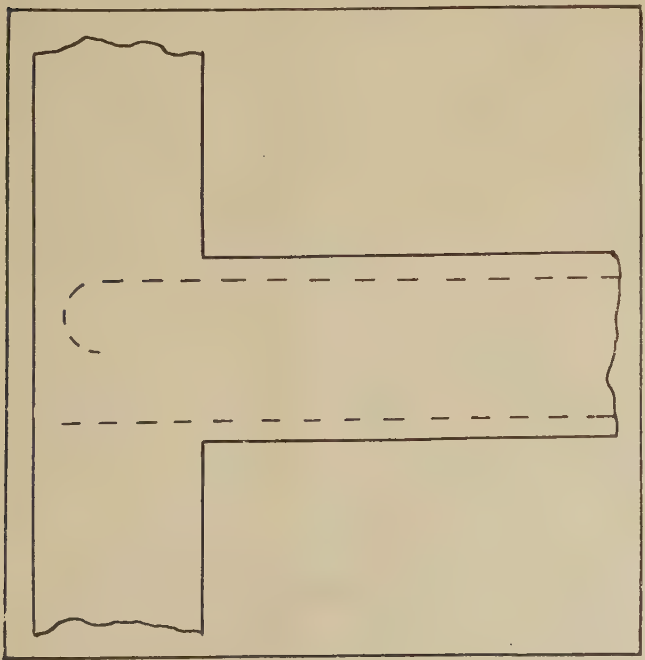


Figure 1-D-2

Fig. 1-D-2 shows the method of obtaining sufficient length for anchorage by adding a hook. In Fig. 2-D-2 a bar splice is shown wherein the length of the lap is the required number of diameters.

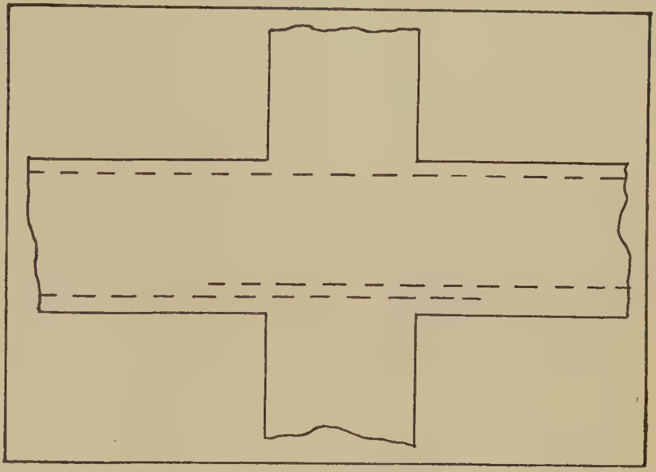


Figure 2-D-2

Construction of Chart D-2

The expression for the unit bond stress in reinforced concrete beams

$$u = \frac{V}{\Sigma ojd} \tag{Eq. 1-D-2}$$

can be written, using the average value of $(j = 7/8)$, as

$$u = \frac{V}{\Sigma od\,0.875}$$

Since the sum of the perimeters of all bars (Σo) is found by multiplying the perimeter of one bar by the total number of bars, this equation is in reality a five variable expression. Since nomographs of more than four variables begin to look complicated, the writer's original intention was to omit this one from the series. However, as mentioned before, a number of individuals have requested it. Such an expression is not recommended to the beginner in nomograph construction. Only by constant tinkering and many trials will the reader design one to his entire satisfaction.

In all expressions of more than three variables, the first step in nomograph construction is to obtain a series of three variable equations. The given equation

$$u = \frac{V}{0.875\,\Sigma od}$$

can be transposed to the form

$$u\Sigma o = \frac{V \frac{1}{d}}{0.875}$$

This arrangement is made in order to keep (V) and (d) together as they are fixed for any one beam design. Equating both sides of the equation to a common variable (y) we have

$$\frac{V \frac{1}{d}}{0.875} = y \tag{1}$$

$$u\Sigma o = y \tag{2}$$

A third expression is then necessary in which (o) is the perimeter of one bar and (N) the number of bars

$$oN = \Sigma o \qquad (3)$$

Thus we have three expressions, two of which contain the common variable (y) and two containing (Σo). After several trials a value $(r = 1)$ was assumed for each of the first two expressions (see general nomograph theory in March issue)

$$C = L^{mn/r} . R^{m(1-n)} \qquad \text{Eq. 7}$$

In each of these first two expressions

$$y = \frac{V \frac{1}{d}}{0.875} \qquad (1)$$

$$y = u\Sigma o \qquad (2)$$

the exponents of the right hand variables are unity. Equating these actual exponents to the general ones of Eq. 7 we get, with the substitution of $(r = 1)$,

$$\left.\begin{array}{r} \frac{mn}{r} = \frac{mn}{1} = 1 \\ m(1-n) = 1 \end{array}\right\}$$

Solving these two expressions simultaneously we get the values

$$n = \tfrac{1}{2}$$
$$m = 2$$

The $(K\text{-}10)$ scale was used for the outside scales of expressions (1) and (2) for the values of (V), (d), (u), and (Σo). Since values of (y) were of no interest, their co-ordinates were omitted and the line marked "Support." The value $(n = \tfrac{1}{2})$ indicates that the support will be midway between the scales of (V) and (d), as well as (Σo) and (u). The co-ordinates for the three scales (V), (d), and (Σo) were laid out to give the desired range of values. Since values of $(\frac{1}{d})$ were plotted in the first expression (1), this scale progresses from the top down. An isopleth, Fig. 3-D-2, was then drawn between the values $(V = 10{,}000)$ and $(d = 10)$. Through the intersection of this isopleth with the support a second isopleth is drawn to a value of $(\Sigma o = 50)$. This second isopleth intersects the unit bond scale at a value of

$$u = \frac{V}{0.875\,\Sigma od} = \frac{10{,}000}{0.875 \times 50 \times 10} = 22.85$$

This gives a point on the unit bond scale from which to start the co-ordinates.

Now for the third expression which is

$$\Sigma o = oN \qquad (3)$$

The central scale, values of (Σo), is already laid out. Assuming this (Σo) scale half way between the two outside scales (o) and (N), we then have a value of $(n = \tfrac{1}{2})$. Equating the actual exponents of expression (3), which are both unity, to the general exponents of Eq. 7, we have

$$\left.\begin{array}{r} \frac{mn}{r} = 1 \\ m(1-n) = 1 \end{array}\right\}$$

If the co-ordinates of the two outside scales are assumed equal, we can substitute the values $(r = 1)$ and $(n = \tfrac{1}{2})$ in the first of the last two expressions getting thereby

$$\frac{mn}{r} = \frac{m\tfrac{1}{2}}{1} = 1$$

$$\text{or} \qquad m = 2$$

Thus the co-ordinates on the two outside scales are equal and twice the size of those used for the central (Σo) scale. The K-10 scale was used for values of (o) and (N) but the writer had no scale available which was just twice this size. Since the plotted points were comparatively few on these outside scales, the K-10 scale was just doubled for the necessary points. An isopleth, Fig. 3-D-2, was drawn horizontally through the value of $(\Sigma o = 9)$. On the left scale a value at this isopleth of $(o = 3)$ was assumed, making the intersection on the right scale

$$N = \frac{\Sigma o}{o} = \frac{9}{3} = 3 \text{ bars}$$

Instead of calibrating the perimeter scale (o), only the location of definite bar perimeters were plotted and labeled the corresponding bar size. The scale showing the sum of bar perimeters (Σo) is in reality a support from which all graduations could be omitted. However, a few values of (Σo) have been shown on Chart D-2 for the convenience of the reader.

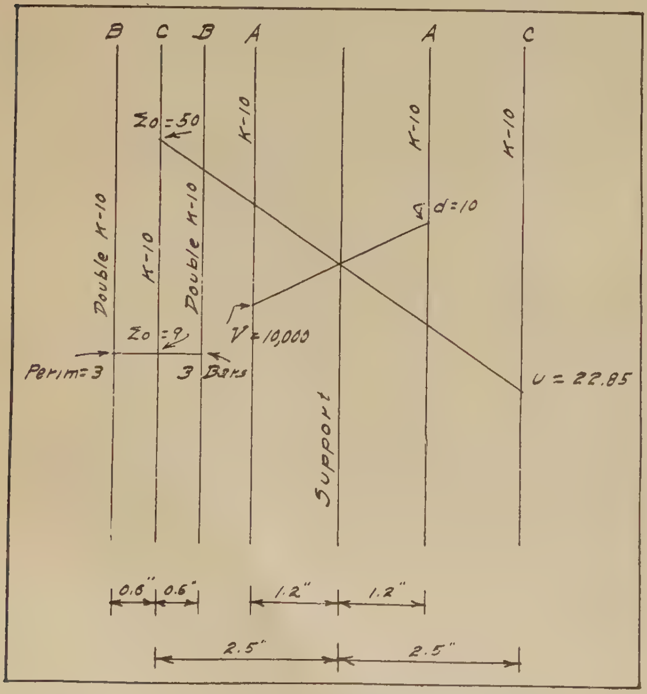


Figure 3-D-2

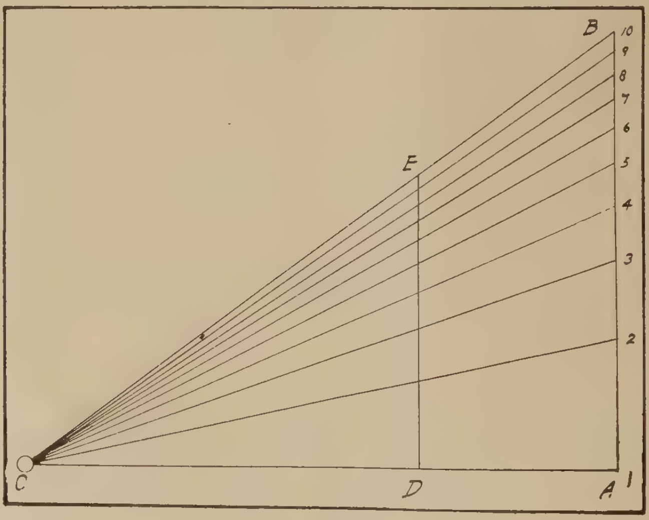


Figure 4-D-2

Logarithmic Scales

A short time ago one reader complained that he could find no scales on his slide rule which quite matched up with those shown on the charts. Fig. 3-D-2 shows the complete information by which the original of Chart D-2 was constructed. However, in making the cuts to conform to the publication page size, a slight reduction has in almost every case been made.

The reader can, with a little care, construct a diagram from which any relative size logarithmic scale may be quickly obtained. Fig. 4-D-2 indicates the general method which is nothing but the principle of similar triangles applied in geometrical reduction. One original log scale (A-*B*) is carefully graduated. Radial lines are then drawn to each graduation on (*A-B*) from some central point (*C*). By erecting a line (*D-E*) parallel to (*A-B*) the original graduations will be reduced on (*D-E*) in the ratio of $\left(\frac{CD}{CA}\right)$. Thus, if a scale is desired having graduations two-thirds the size of the original ones, (*D-E*) is drawn at a location such that $\left(\frac{CD}{CA}=\frac{2}{3}\right)$. If the chart to be constructed is laid out on transparent cloth or paper, the diagram, Fig. 4-D-2, can be slipped underneath the transparent material and the calibrations marked out.

Advantages of Products Plant Consolidations

By **WM. RATHKE**[*]

Eau Claire, Wis.

A great deal of publicity as to the profits made in this business, together with the aggressive advertising and salesmanship of the machine companies, has led many people to invest their money in the concrete products business. Were there actual new business enough to warrant this new capital being put into plants there would be no complaint but the fact is apparent to most of us that there is an overproduction in plants manufacturing concrete products in most localities.

It is a fact that one-half of the plants now operating would, with very little new equipment and designing, be able to supply the products used at this time and would also be able to handle increased business.

The excess of products plants has led to price cutting and other abuses of good business practice. When we overproduce on any commodity we tend to lower the prices at which we sell regardless of the cost of production. This condition cannot go on indefinitely and gradually plants will be eliminated and the surviving plants will reap a harvest providing they, too, have not impaired their capital while this elimination process is taking place. The idea is, if possible, to work out a more equitable solution to this problem. Everyone who invested money in the products business did so in good faith and should be entitled to a fair return on his money so invested. We have read a great deal during the past year of the consolidation of various lines of business.

Can we not borrow from the experience of others and work out some such plan in our business? Of course, it would not be feasible to organize a whole state but the state is made up of districts toward which business naturally gravitates and these districts and cities can very easily consolidate their experience and their assets for mutual profit.

When we stop and think of the money that can be saved we realize that it is a natural thing to do. Sales and advertising expense would be saved. In fact, overhead items would all be reduced by more than one-half. Delivery expense would be saved as orders could be delivered from the closest plant. Plants not now operating profitably due to location or design could be eliminated. We would save labor on the production end. All of us now are carrying labor through the slack seasons in order to keep experienced men.

In consolidating, both sales and production would be under one management and a crew of much smaller size working on a twelve-months' schedule and properly handled on a piece-work basis would undoubtedly produce enough units to supply the demand. A fair price could then be obtained for our products and uniform quality could be maintained. One large company manufacturing a good uniform product passing required tests could exert enough influence with architects and contractors not now favorable to concrete products so that our goods would be specified on more and larger work.

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[*] From a paper presented before the Wisconsin Concrete Products Association.

London Builds First Mosque of Concrete

Concrete with steel framing was used in the construction of London's first mosque, in simple Indo-Saracenic style. The mosque has the usual features of a central dome and four minarets.

Thomas Mawson & Sons, London, were the builders.

Coming Conventions

American Concrete Institute—February 12th to 14th, 1929. Twenty-fifth annual convention, at the Book-Cadillac Hotel, Detroit, Mich.

American Road Builders Association—January 14th to 19th, 1929. Convention and road show, at the Cleveland Public Auditorium, Cleveland, Ohio.

Concrete Reinforcing Steel Institute—October 1st to 3rd. Fall meeting, at Buckwood Inn, Shawnee-on-Delaware, Pa.

Design of Mix for Small Size Pipe

A Discussion of an Article Published Under the Above Title in the June Issue—Agrees on Fineness Modulus of 3.70, but Uses More Fines

By E. F. BESPALOW
Supervising Engineer, Shearman Concrete Pipe Co., Inc.

I HAVE read with considerable interest the article by F. R. Zaugg on "Design of Mix for Small Size Pipe" in your June issue and wish to comment on it.

I heartily agree with Mr. Zaugg's preliminary statements in his article but take issue with him on some of his remarks regarding aggregate grading and on the typical screen curve for grading of aggregate for small size concrete pipe. I also feel that his statement that "It is better, therefore, to use only natural pea gravel," is too general and does not hold true in all cases.

The Shearman Concrete Pipe Company operates ten modern concrete pipe plants in the following cities: Norfolk, Va., Knoxville, Tenn., Chattanooga, Tenn., Montgomery, Ala., Atlanta, Ga., Savannah, Ga., Jacksonville, Fla., Lake Worth, Fla., Bartow, Fla., and Tampa, Fla., and our experience has been that the aggregate for small pipe must be so graded as to have at least 15 to 20 per cent material pass the No. 48 sieve to insure pipe that will pass the hydrostatic test satisfactorily.

We use a crushed stone aggregate at all of our plants in the manufacture of small size pipe. The material is a hard dolomitic limestone which is the by-product of a zinc mine at Mascot, Tenn., and has a cubical fracture, which we have found gives better and stronger pipe than can be obtained with the use of pea gravel. Our experience with the comparative strengths of pipe made from pea gravel and crushed stone is borne out by recent tests by the United States Bureau of Public Roads in which it was shown that crushed stone concrete had a 12 per cent higher modulus of rupture than gravel concrete of equivalent quality and grading of aggregate. Concrete cylinders made with a 1:2:2.5 mix using the above mentioned crushed stone give strengths at 28 days that are well over 5,000 lbs. per sq. in. This stone comes to us graded from ⅜-in. to 10 mesh with a fineness modulus of 5.19.

Fine Graded Sands

The sands available for use at our Florida plants are naturally fine graded and we use a sand which has from 25 to 35 per cent passing the No. 48 sieve. At our more northern plants the available sands are not always graded fine enough and here we add a limestone dust to secure the necessary fine material to insure pipe of good hydrostatic qualities.

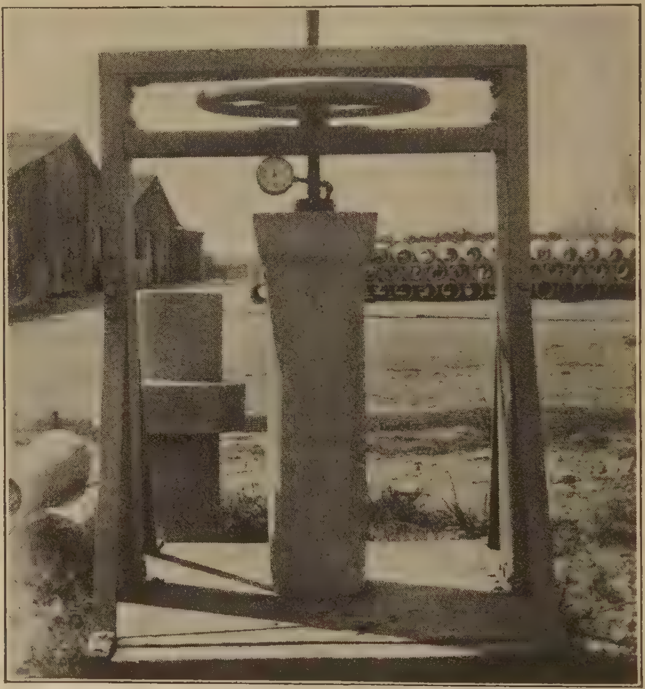
I heartily agree with Mr. Zaugg on his figure of 3.70 for the F. M. of the mixed aggregate for small pipe, as this is the ideal we strive for; but as stated, I feel that the critical sieve is the No. 48 and insist on 15 to 20 per cent material passing this sieve in the mixed aggregate. It is this fine material which fills the minute voids in the pipe and makes it watertight.

The screen curve of the mixed aggregate which we use would be very similar to the dotted one in Mr. Zaugg's article which he labels, "poor grading—porous pipe."

We make a practice of testing pipe at all of our plants regularly and we have repeatedly run our hydrostatic tests on pipe up to 90 lbs. per sq. in. without leakage and it took a pressure of 165 lbs. per sq. in. to burst one of our 6-in. pipe which has a ¾-in. wall thickness and is made with a 1:2:2.4 mix. Strength tests on our small pipe run from 60 per cent to over 100 per cent more than the requirements of the American Society for Testing Materials.

Use Leaner Mix

Mr. Zaugg takes exception to the large percentage of material retained on the No. 4 sieve as shown on his dotted curve, but I feel that this is necessary in gaining strength to make up for the weakening effect of the large percentage of fine material. Mr. Zaugg also objects to a large percentage of fine material because it makes the pipe sticky and difficult to remove the jackets from the green pipe. We have no difficulty from this source but I assume it is due to the fact that we use a considerably leaner mix than the 1:2.5 which he mentions in his article. Our mix on small pipe ranges from 1:2:2 to 1:2:2.4 depending upon the gradation of the sand.


Pipe containing 15 to 20 per cent material passing the No. 48 sieve proves satisfactory in the hydrostatic test

It thus will be seen that it is possible and practical to produce very excellent small size pipe even with aggregate that, according to Mr. Zaugg, is poorly graded, and is not the best type to be used for small pipe.

A. S. T. M. Presents Reports on New Cement and Concrete Research

Important Data on Cement, Concrete and Concrete Aggregates Contributed at Atlantic City Meeting of the American Society for Testing Materials—Methods of Testing Analyzed—Report of Committee C-1, on Cement, Stresses Need for Greater Uniformity of Testing Procedure—Plastic Mortar Test for Cement Proposed—Developments in Concrete—Aggregate Tests and Grading Discussed

IN practically all of the committee reports and the papers relating to cement and concrete presented at the meeting of the American Society for Testing Materials, held June 25th to 28th, at Atlantic City, the need for developing better methods or new methods for testing the various qualities of cement and concrete was stressed. The reports of nearly all of the sub-committees on cement made this need their main theme; Mr. Brickett's paper on "A Plastic Mortar Compression Test for Cement" voiced the hope that some means of devising a specification test for portland cement that would give a true indication of concrete-making qualities might be found; two papers discussed methods of measuring workability; and durability and strength tests were considered.

As was the case in the last meeting of the American Concrete Institute, the discussions were aimed primarily at efforts to know more about cement and concrete and to determine their properties more accurately.

Report of Committee on Cement

Committee C-1, on cement, presented a report covering a remarkable study on cement testing. This report is the result of several years' study, being based on tests made on 32 cements, tested by 47 laboratories. The more than 63,000 strength tests made, classified and studied give some indication of the magnitude of the work involved.

The work has yielded some far-reaching and important results. Perhaps its greatest significance is to be found in the wide variations of test results from the same cements in different laboratories. Commenting on this feature, the committee says: "Those who are inclined to believe that the requirements of the present A. S. T. M. Standard Specifications for Portland Cement (C9-26) are low should study these results with care. When different reputable laboratories do secure results as widely variant as those indicated, and when some of these would have condemned a cement as not meeting the requirements when so many other laboratories would have approved the cement as meeting those same requirements, it is plainly evident that for a national standard, for a country geographically as large as ours, tolerances must be considerably greater than any one individual consumer might wish to employ. All of these cements would have been passed by the majority of the laboratories, yet three of the laboratories would have rejected practically all of the cements. * * *

"These, as well as other previously obtained data, indicate that the various laboratories do not obtain the concordance in their testing that good commercial practice demands. Whether a cement is meeting the requirements of the standards seems now too frequently to be a matter of choice of laboratory."

The result of this investigation was that the Advisory Committee was instructed to appoint a committee whose special duty it will be to "study this situation along the lines of establishing a special laboratory where instructions could be given in carrying out the tests according to the prescribed methods, where the equipment used in testing could be calibrated and examined to see if it met with the desired requirements and which would, when so requested, act as an umpire in settling disputes between laboratories as to any test requirement. This is a matter of considerable moment, as it is an attempt to develop an active central medium which would be recognized as authoritative in the interpretation and application of testing methods of cement."

A Plastic Mortar Compression Test for Cement

In an effort to devise a specification test for portland cement which will give a true indication of the concrete-making qualities of cement, Edward M. Brickett, engineer of tests for the Research Division of the Lehigh Portland Cement Co., made some studies based on plastic mortar tests which were compared with carefully controlled compression tests of concrete cylinders. The plastic mortar mixes were made with 1 part of cement to 2.75 parts of sand which was constantly graded. These were made into 2-in. cubes with a water-cement ratio similar to the companion concrete cylinder with which the test results were compared.

Concrete compression tests were made on 3- by 6-in. cylinders made with definitely graded aggregates and proportioned 1:2.04:3.04 by volume. These were mixed to a consistency of 80 per cent, giving a water-cement ratio of approximately 1.00, or 7½ gal. of water per sack of cement. These were cured under definitely uniform conditions and tested at ages of 1, 2, 4, 7, 14 and 28 days.

It was found that the advantages of this test include:

1. It gives a more nearly correct measure of the concrete-making qualities of cement than does any other indicator test used or proposed to date.

2. The plasticity of the mortar minimizes the effects of personal factor of operators and of minor variations in technique.

3. Specimens are more easily made than in the case of standard Ottawa sand mortar because the mix is plastic and more easily worked.

4. It may, though it has not yet been shown that it surely will, obviate the necessity for a single standard sand.

5. It offers an entirely feasible means for making early strength tests. With good control, tests at 24 hours have been shown to be in close agreement with concrete tests at that age.

6. The absolute strength of the plastic mortar is fairly close to that of the concrete.

Workability

Two papers on the subject of workability were presented—"The Measurement of Workability of Concrete," by George A. Smith of the Celite Co., and "The Determination of the Workability of Concrete," by W. F. Purrington and H. C. Loring, both of the New Hampshire State Highway Department.

Mr. Smith's paper describes an improved penetration apparatus for measuring workability of concrete. The apparatus is similar to that described in a paper presented by Mr. Smith and Mr. George Conahey at the last meeting of the American Concrete Institute and reported in the April, 1928, issue of CONCRETE.

In this later paper, additional data are presented which show that the indices obtained closely check observations made in the field. The author feels that the improved penetration apparatus is capable of demonstrating in a consistent manner changes in workability caused by variations in cement content, fineness of sand, grading of coarse aggregate, etc. He says, "The indices obtained from the tests are consistent with field observations and with the judgment and observations of experienced investigators. Within the range of plastic mixes, the apparatus functions to give a true index of the workability."

An entirely different method of determining workability of concrete was suggested in the other paper by W. F. Purrington and H. C. Loring. These investigators found that workability could be determined by measuring the power consumed in mixing the concrete. They presented results from a number of tests in which the load applied to the mixer was measured by a polyphase wattmeter supplied with proper transformers. They found that:

1. Power consumption increases with the richer concrete mixtures.

2. The time required uniformly to mix concrete may be determined by the power curve.

3. The rate of absorption of water by the cement particles varies greatly with different brands of cement; the greater the hydration the greater the power consumption and *vice versa.*

4. The investigation opens a way for productive research on various types of admixtures.

Durability of Concrete

Some interesting views on the much discussed subject of durability of concrete were presented by Prof. C. H. Scholer of Manhattan, Kas., in his paper on "Some Accelerated Freezing and Thawing Tests on Concrete." The tests described are the outgrowth of about four years of investigation of concrete deterioration in Kansas highway structures. It was first thought that disintegration was due to alkali action, but this opinion was found to be at fault because of the low concentration of salts and because many of the worst cases were found in pure water.

A study of these structures led to the belief that disintegration was caused by some lack in the concrete itself rather than the severity of the exposure. A parallel field and laboratory investigation was therefore made to determine the effects of alternate freezing and thawing on concretes made under varying conditions. These tests revealed that variations in the water-cement ratio of plastic workable concrete has a very decided effect upon its durability. It was found that a water-cement ratio of 1.0 is near the maximum permissible for a desirable durability in exposed conditions. Unsound aggregate produced unsound concrete, the resistance of the mortar to disintegration being only slightly effective in protecting the concrete.

Prof. Scholer believes that it is possible to study the durability of concrete by means of accelerated alternate freezing and thawing tests in the laboratory. This investigation and the conclusions drawn give the industry some very valuable data on a subject about which very little has been published and which is now becoming of paramount importance.

Resistance to Sulphate Waters

In his paper, "Resistance of Portland Cement Concrete to Sulfate Waters Influenced by the Cement," Dalton G. Miller described a series of tests to determine the resistance of concrete made from 30 portland cements to the action of sulphate waters. The tests show that standard portland cements vary greatly under these conditions of exposure, some outliving others by as much as eight times. It was shown that the standard physical and chemical analyses of cements gave no indication of their ability to resist sulphate water but that the cements which failed quickly under the accelerated laboratory tests displayed low resistance in the field.

"Volume Changes of Portland Cement as Affected by Chemical Composition and Aging," was the title of a paper presented by Prof. Alfred H. White of the University of Michigan. In this paper, which discusses the tests made with neat cement bars, some of which have been under observation for 26 years, Prof. White draws some new conclusions. He says that (a) "Free lime causes an unusual expansion during the first few weeks in water, but its hydration should be finished in a year and if the amount of free lime was small, the volume changes beyond that time should be small." (b) "Magnesia in combination as silicate is entirely harmless, no matter how much there may be in the cement. Free magnesia hydrates slowly and causes rather slight additional expansion during the first 3 years in water; but if much magnesia is present, it causes marked expansion during the period from the third to the tenth year in water." (c) "Increasing the iron oxide in a cement seems to decrease volume changes. The cements which have been most constant in volume are those which are rather low in alumina, and contain more iron oxide than alumina. Cements high in alumina have shown rather high volume changes." (d) "Aging for a cement which contains free lime will remove the harmful effect of the free lime, but aging does not eliminate the normal volume changes of a cement nor does it seem to lessen them in any material degree."

Another paper, "Permeability of Concrete," by Ira L. Collier, is presented in full on other pages of this issue.

Concrete Design

Three papers, dealing with tests that have reference to concrete design problems were presented. The first of these, "Experimental Tests of Concrete-Steel Bond," by L. N. Edwards and H. L. Greenleaf, describes tests made to secure information relating to the bond produced between concrete and steel reinforcement bars under good field construction practice. With different concrete mixes, varying results were obtained. For instance, rich mixes produced less bond strength than leaner mixes, and the variation of the water content of a concrete mix affected the intensity of the concrete steel bond. Assuming as a basis for comparison a normal, semi-plastic mix, an increase in the water content caused a reduction in the bond strength.

The need for a standard method of making flexure tests was pointed out by T. F. Willis and F. N. Wray in a paper entitled "The Effect of Several Mechanical Features of Testing on the Determination of the Flexural Strength of Plain Concrete." The paper points out the diversity in the methods used to make flexural tests and shows the wide variations of results obtained when the different methods are used.

An investigation made by H. F. Gonnerman and E. C. Shuman to determine the effect of factors which are known to influence compressive strength on flexural and tensile strength of plain concrete was reported in a paper "Compression, Flexure and Tension Tests of Plain Concrete." The results of these tests are particularly interesting in the light of the comparative tests made by the Bureau of Public Roads on gravel and stone concrete ("CONCRETE," June, 1928). It was shown that such factors as size and grading of the aggregate affect the compressive and tensile strengths and the modulus of rupture of concrete of a given mix and consistency only as they affect the amount of water required to produce the desired consistency.

The authors recommended that "flexure" tests for field control of concrete quality should be used with some caution, particularly with coarsely graded aggregates, since tests of undersanded or honey-combed and porous concrete might, through the higher flexural strengths, indicate a better quality of concrete than was actually being obtained."

An important conclusion was that: "The relationships between the water-cement ratio and the modulus of rupture and tensile strength of plastic, workable concrete mixes are similar to the water-cement ratio-strength relations for compression tests, showing that for given materials and methods of manipulation, the water-cement ratio is a governing factor in the strength of concrete whether it be tested in compression, flexure or tension."

Permeability of Concrete

By IRA L. COLLIER
Assistant Professor of Civil Engineering, University of Washington, Seattle, Wash.

SYNOPSIS—The paper describes a method of determining the flow of water through concrete, the water being under a pressure of 145 lb. per sq. in. Three series of experiments are reported. In the first series, all factors were constant except the water-cement ratio of the concrete, which varied from 0.6 to 1.2. In the second series, all factors were constant, including the water-cement ratio, except the slump which varied from a dry mix to a wet mix. In the third series, water-cement ratio and slump were constant, but the percentage of sand and gravel was varied, giving variable fineness moduli.

These tests have shown: (1) a general straight-line relationship between flow of water through concrete and water-cement ratio, when the data are plotted to logarithmic scale; (2) that the flow decreased as the cement content was increased, although no definite relationship has been established; and (3) that the flow decreased with decrease in fineness modulus.

THE suggestion for making this apparatus for determining the permeability of concrete described in this paper was obtained from the University of Wisconsin. The apparatus was made from steel pipe and fittings, and Fig. 1 shows the detail of a single holder. This figure will be referred to later when describing the method of operation.

Materials and Specimens

Cement.—Ten sacks of "Superior" brand cement were spread out on a clean concrete floor and thoroughly mixed by hand, then stored in metal containers. Tests made by students indicated that the cement was normal in all respects.

Sand.—All sand was dried and separated on Tyler screens. The different sized particles were then re-combined in the following proportions: Material retained on No. 4 sieve, 0 per cent; on No. 14 sieve, 11 per cent; on No. 28 sieve, 20 per cent; on No. 48 sieve, 66 per cent; and on No. 100 sieve, 3 per cent. The fineness modulus was 2.39.

Gravel.—All gravel was dried and separated on screens having circular openings. The different sized particles were then re-combined in the following proportions: Material retained on 1½-in. screen, 0 per cent; on 1-in. screen, 11 per cent; on ¾-in. screen, 19 per cent; on ½-in. screen, 40 per cent; on ¼-in. screen, 25 per cent; passing ¼-in screen, 5 per cent. The fineness modulus was 6.94.

Proportions, Mixing, and Curing.—Thirteen pounds of sand and 26 lbs. of gravel, graded as stated above, were used in the first two series. Specimens were 9 in. in diameter and 8 in. high. In the first series, the variable studied was the water-cement ratio. The water and cement were mixed in the desired ratio and enough of this slurry was added to the sand and gravel, which had been first mixed thoroughly, to produce a concrete having a consistency measured by a 4-in. slump. The water-cement ratios studied in this series varied from 0.6 to 1.2, increments being even tenths.

In the second series the consistency of the concrete was varied while the water-cement ratio was held constant at 0.9. Enough slurry was added to the sand and gravel first to give a zero, then ½-in., 2-in., and 8-in. slump.

In the third series the water-cement ratio was held at 0.9, the slump 4 in., and the relationship between the sand and gravel was varied as follows: 20:80, 30:70, 40:60, and 50:50.

The proportions water-cement ratio, slump, density,

A paper presented before the American Society for Testing Materials at Atlantic City, New Jersey, June 25th to 28th.

and other properties of the concrete in these three series are given in Table I.

The time of mixing for all specimens was 1½ minutes. All concrete was placed in the molds in three layers, each layer being tamped twenty-five times with a standard 24-in. bullet-pointed ⅝-in. round bar. Five specimens of like conditions were made on the same day. The next day the specimens were taken from the molds and stored in water the temperature of which varied between 65 and 75 deg. Fahrenheit.

Method of Testing

Twenty-eight days after the specimens were made they were taken from the water, wiped off, placed close to a radiator to dry the surface, then given a coat of asphalt which had been cut back with kerosene. The testing apparatus was then set up in a vertical position, the companion flanges *A*, Fig. 1, having been disconnected. The specimens were then centered in the 10-in. opening. Asphalt just hot enough to pour easily was then poured in the ½-in. opening around the specimen, at *K*. In order that the specimen would have a good bearing against the outer flange *B*, it was necessary to cap that portion of the specimen with some quick setting material. A mixture of 2 parts Lumnite cement and 3 parts portland cement was found to set hard in 15 minutes. A ring of this material, *J*, mixed with water to a stiff paste, was placed on top of the asphalt. The outer flange, well oiled, was then set in place. The cement that squeezed out into the opening *C* was cut away after hardening. The holder was then lowered to a horizontal position and the companion flanges *A* connected. Valve *D* was then opened and the apparatus filled with water to the top of the gage *E*. Air was allowed to escape from petcock *F*. The next morning all the nuts to the outer flange were tightened (this was found necessary, as the slightest movement of the specimen would break the asphalt seal) and the air pressure turned on, valve *G*. The air pressure was held between 143 and 148 lb. per sq. in. by means of the reducing valve *H*. The compressor held the pressure between 200 and 240 lb. per sq. in.

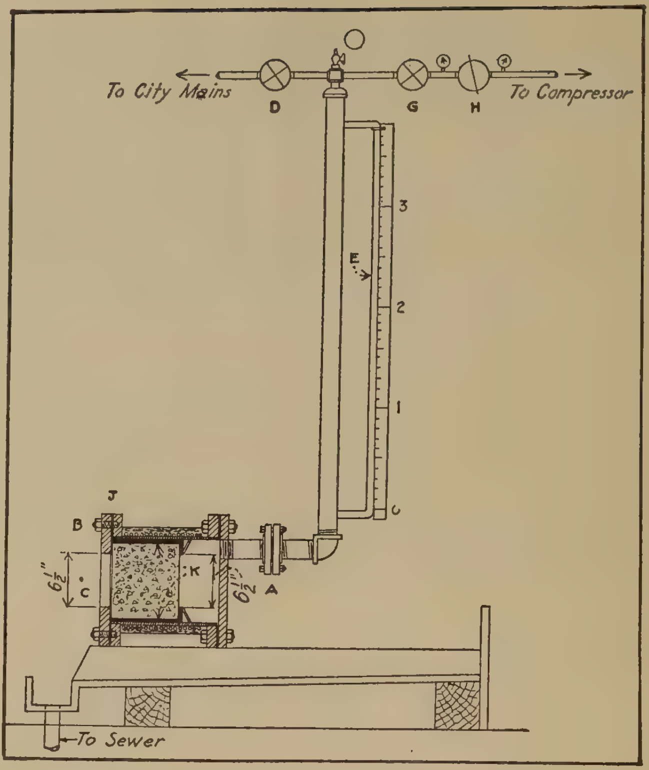


Fig. 1. Diagrammatic sketch of apparatus for determining permeability of concrete.

Readings of the gage were then taken for six days, at which time a new set of specimens was ready. The frequency at which the readings were taken depended on the rate of flow, never less than two readings a day. In some cases where the rate of flow was high, it was necessary to refill the columns every few hours. In these cases the pressure was cut off during the night.

To remove the specimens from the holder, electric cur-

TABLE I.—TEST DATA ON PERMEABILITY OF CONCRETE.

All values of flow are average of 5 tests, unless otherwise indicated.
Specimens 1 to 9 were made by L. A. Carter, a research student; the others were made by the writer.

			—Proportions by Weight—							Quantity of Materials per cu. yd. of Concrete					
Series	Set No.	Fineness Modulus	Cement	Sand	Gravel	Water-Cement Ratio	Slump, in.	Density	Weight, lb. per cu. ft.	Cement, bbl.	Sand, lb.	Gravel, lb.	Flow, gal. per hr. at end of 100 hr.	Mean Error per cent	Condition of Surface at end of 100 hr.
I	1	5.41	1	1.14	2.28	0.6	4	0.853	145	2.39	1020	2040	0.000063	31	Dry
	2	5.41	1	1.66	3.32	0.7	4	0.861	......	1.77	1100	2200	0.000071	17	Dry
	3	5.41	1	2.22	4.44	0.8	4	0.856	......	1.37	1140	2280	0.0134‡	35	Wet
	4	5.41	1	2.82	5.64	0.9	4	0.850	......	1.12	1160	2320	0.00064	59	Dry
	5	5.41	1	3.02	6.04	1.0	4	0.842	......	1.02	1160	2320	0.0091	47	Wet
	6	5.41	1	3.52	7.04	1.1	4	0.830	......	0.87	1150	2300	0.0379†	74	Wet
	7	5.41	1	3.76	7.52	1.2	4	0.816	......	0.80	1140	2280	0.049†	69	Wet
II	8	5.41	1	3.26	6.52	0.9	0	0.790	140	0.89	1090	2180	0.406*	65	Wet
	10	5.41	1	2.81	5.62	0.9	½	0.793	140	1.04	1070	2140	0.0659†	57	Wet
	11	5.41	1	2.48	4.96	0.9	2	0.813	149	1.18	1080	2160	0.00138	52	Wet
	12	5.41	1	2.21	4.42	0.9	6	0.819	148	1.30	1080	2160	0.00026	27	Dry
	9	5.41	1	2.00	4.00	0.9	8	0.811	147	1.41	1070	2140	0.00095	32	Wet
III	13	6.03	1	1.50	6.00	0.9	4	0.840	150	1.20	680	2710	0.00082	27	Wet
	14	5.56	1	1.93	4.51	0.9	4	0.801	147	1.31	950	2140	0.00063	54	Wet
	15	5.11	1	2.27	3.40	0.9	4	0.782	145	1.44	1220	1840	0.00030	26	Dry
	16	4.66	1	2.46	2.46	0.9	4	0.754	141	1.56	1440	1440	0.00077§	36	Wet

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*Average of four tests.
†Average of three tests.
‡Specimens were three days late in being placed in curing water.
§Specimens were one day late in being placed in curing water.

rent was applied to the coil of resistance wire wrapped around the pipe. The wire was insulated from the pipe by means of a sheet of mica and in order that the heat would not be dissipated, the outside of the pipe and coil were given a thick coat of insulating material. A sheet of galvanized iron then protected this material. The outer flange was then taken off and in a few minutes the weight of the column of water would force the specimen out. The apparatus was then ready for a new set of specimens.

Test Data

The apparatus having been calibrated, the gage readings were reduced to gallons and plotted against the hours of elapsed time. A smooth curve was then drawn through the points and a tangent to the curve drawn at the 100-hour ordinate. The slope of the tangent gave the rate of flow in gallons per hour at the end of 100 hours. This value for all specimens was then taken as the unit for the study of the permeability of concrete and will hereafter be spoken of as "the flow." A typical plot is shown in Fig 2.

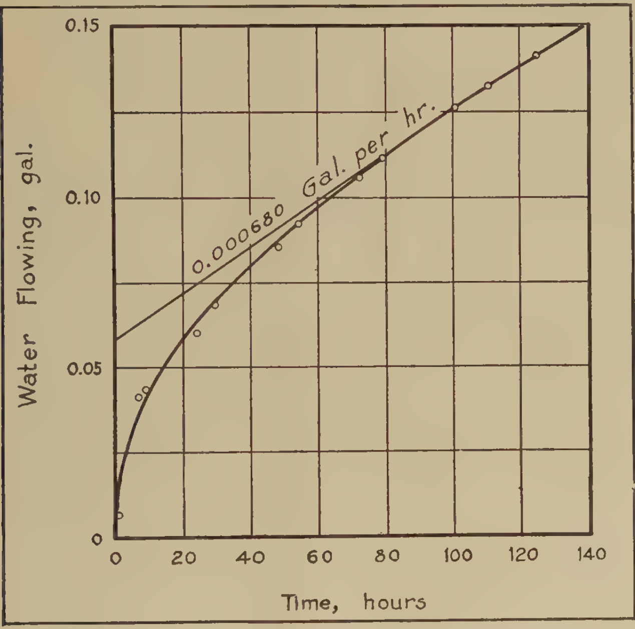

Fig. 2. Typical flow curve (specimen 1, set 9, second series)

The average values of flow, as thus determined, for the specimens of the three series are given in Table I. Except where noted, each value of flow reported is the average of five tests.

Values of flow for individual specimens have been plotted against water-cement ratio to logarithmic scale in Fig. 3 (*a*), the data being taken from the specimens of the first series as well as from specimens in a preliminary series. A straight line drawn to average the points thus plotted has the equation $P = 0.007\ x^{15}$, in which P is the flow and x is the water-cement ratio. In Fig. 3 (*b*) are plotted the average flows as determined for the specimens of series 1 and reported in Table I. With the exception of the value of flow of 0.0134 gallon per hour for tests No. 3, water-cement ratio 0.8, the straight-line relation as expressed by the above equation is fairly representative of these data.

In this series specimens with the water-cement ratio of 1.0, 1.1 and 1.2 leaked water at all times; specimens with a water-cement ratio of 0.9 showed water on the surface for the first two days only, after which time the water evaporated as fast as it came through. The richer mixes showed no sign of water on the surface at any time. It is probable that the high value of flow for the specimen of 0.8 water-cement ratio has been caused by improper curing of the specimens of that set since they were three days late in being placed in curing water.

The test data from the second series, in which the consistencies of the concrete were varied, have been plotted in Fig. 4. The specimens containing 0.89 and 1.04 bbl. of cement per cubic yard of concrete would be classed as unworkable. More data taken from specimens in the plastic or workable zone are needed before definite conclusions can be drawn. However, it appears that in general flow is decreased as the cement content has been

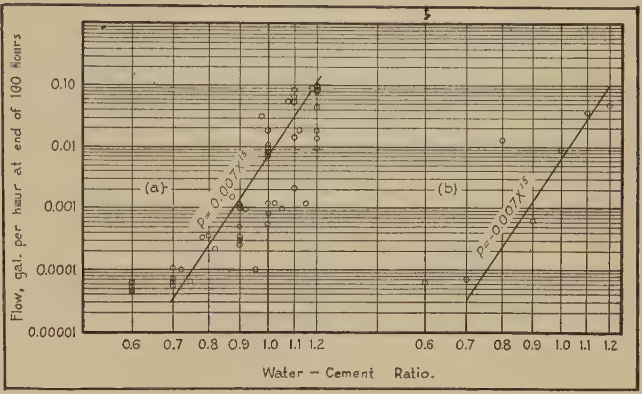

Fig. 3. Illustrating the relation between permeability and water-cement ratio (first series)

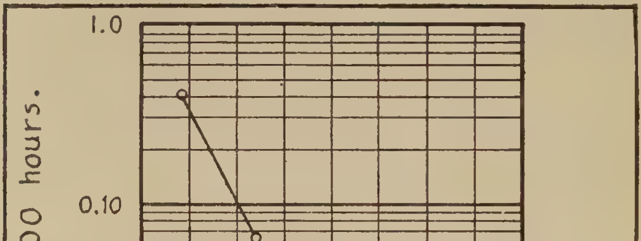

Fig. 4. Illustrating the relation between permeability and quantity of cement (second series)

increased, although no definite relationship has been established.

The test data from the third series have not been plotted; but it may readily be seen from Table I that, except for the last set of tests, No. 16, fineness modulus 4.66, the flow through the concrete is decreased almost directly in proportion to increase in percentage of sand. It was found that the specimens of set No. 16 were one day late in being placed in curing water and this fact, in conjunction with the high flow reported for set No. 3, which had also been improperly cured, emphasizes the necessity for the complete curing of concrete which is to be subjected to high water pressures.

"Cinder Block Ribbed Type Floor Slab Construction

A discussion by J. P. Thompson of the original article under that title

In the July issue of the magazine CONCRETE, is an article entitled "Cinder Block Ribbed Type Floor Slab Construction" which I am afraid gives some erroneous ideas unless a very careful study is made of the data contained therein. It gives information concerning a test to destruction of a small section of tile joist floor. While it is not ostensibly published as a typical design, it will, undoubtedly, be used for this by some readers.

The size of the section and the method of loading are not in accordance with good testing practice. In the section tested, there are three joists taking the load normally carried by only two. A span of 12 feet is less than would ordinarily be used in a typical design. Loading with bags of cement as illustrated, causes arching action in the load so that part of it is carried to the walls through the load itself rather than through the slab. This reduces the bending moment considerably. It is unfortunate that ⅝-inch square bars were used as these are not among the standard sizes.

The allowable live-load on a floor designed as here illustrated would be limited to 80 lb. per sq. ft. by the allowable shear in the beams instead of the 150 lb. as stated in the text. This would apply to a floor of simple span only. With continuous spans, the negative moment over the supports may reduce the allowable load still further.

The test to failure gives results as might be expected. The crack was undoubtedly due to bond failure, as suggested by Mr. Hill. If the ends of the lower rods had been hooked as is general practice in the best design an even greater load could have been carried.

Tests such as these do add greatly to the confidence of the public in concrete floors. The chief objection is that one not familiar with design and testing would use this as a typical design.

International Concretors Hold Convention in France

European concrete and other construction technicians gathered recently at Paris to attend the International Convention of Reinforced Concrete and Masonry. More than 500 delegates, representing twelve countries, attended the meetings and took part in the discussions of reports and resolutions.

Among the subjects discussed were those of mechanical equipment, transportation, accident prevention, suppression of frauds, standardization of methods and technical terms, building credits and apprenticeage.

A permanent international bureau was created with headquarters temporarily located at the offices of the Paris Chamber of Masonry and Cement Contractors, 3 rue de Lutece. M. Cellerier, director of the testing laboratories of the Conservatory of Arts and Trades, was appointed president of the bureau.

A permanent international technical committee composed of a delegate from each country at present taking part in the conventions—Austria, Belgium, Denmark, Egypt, France, Great Britain, Holland, Italy, Luxemburg, Spain, Switzerland, and the United States—and representatives of various European technical bodies was also formed. This committee has been charged with the study of various technical and professional questions. Problems arising before the next convention, which will be held in Liege, Belgium, in 1930, will be referred to groups qualified to seek proper solutions.

One of the important questions to be studied is that of transportation. The comparative costs of rail, water and motor truck transportation will be carefully studied as well as modern methods of loading, unloading and handling of materials.

A. C. I. Plans for 1929 Begin to Take Shape

Although six months have yet to elapse between the present time and the meeting of the American Concrete Institute, the program committee has adopted an outline of its plans, as follows: On Tuesday, February 12th, the usual luncheon will be held, the opening session taking place at 2 p. m. The latter will be devoted to the subject of destructive agents and protective treatments, being built around the subject matter of the work of Committee E-6. The second session of the day will begin at 8 p. m., when Detroit structures and the concrete in them will be discussed. Three papers have been scheduled to date.

There will be no session on the morning of the 13th, but the afternoon will have two concurring, on concrete stone and ornamental concrete and on research. In the evening there will again be concurrent sessions, on the development of reinforced concrete specifications in the last ten years, in symposium form, and on standard concrete building units, based on the work of Committees P-1 and P-6.

Two full sessions are scheduled for the following day. The subject of the day will be, "What does the concrete field regard as a standard of performance in the material concrete in a number of widely different applications and how is concrete of a quality for those different uses to be obtained?" At this time thought will be given to characteristics of concrete other than strength and including such topics as wear resistance in pavements and floors, resistance to sea water, livability in houses, and weather resistance of exposed work.

Road Builders Association Makes Hotel Provisions

The American Road Builders Association has already established a hotel bureau with which reservations are to be made for the 1929 convention and road show at Cleveland, Ohio, on January 14th to 18th, inclusive.

A hotel committee has exclusive control of all rooms in choice hotels and room assignments are to be made through it. A. J. Kennedy, 1604 Terminal Tower Building, Cleveland, vice-chairman of the committee, is in charge.

On October 15th, initial assignments will be made and applications received after that date will be assigned in the order of date received.

From the Products Associations' Bulletins

Wisconsin Concrete Products Association

JACK FRANKLIN, Secretary

THE Wisconsin association expects to reach new heights in its good work as the result of having recently installed Jack Franklin as secretary, as announced in its Circular Letter No. 1, by L. E. Grube, president.

The program formulated by this association for 1928 might well serve as a pattern for others—it covers a wide range of ground and if thoroughly carried out to a finish, should leave a lasting mark.

The first item given in the outline contained in a recent bulletin concerns the production of quality products "by a practical application of laboratory methods of plant operation," and at the same time reducing production cost.

Effecting a wider distribution, according to the program, is to be accomplished by the use of modern methods in both merchandising and advertising.

Four other factors included in the program on which work has been and is being done are law enforcement, education, freight rates, and publicity. The first of these calls for work with state and local officials toward the end of legislation limiting the use of masonry products to those of quality only. The second step on the program, that of education in the use of products and in the methods used to control their quality, is to be applied not only to the building public, but to association members and employes as well. Fair freight rates that permit competition with related materials and allow market expansion are to be sought. Proper publicity in both national and local publications, members are advised, is not to be shunned, but should be used at every opportunity.

In construction, above grade uses are to be sought for products, particularly in house construction. In large building work, co-operation is advised with the architect, contractor and builder to include concrete products in specifications for factories, warehouses and public buildings.

Iowa Concrete Products Association

R. L. GAVIN, Secretary-Treasurer

THE June bulletin of this middle-western association contains an interesting lead item on "A Formula for Successful Selling." Two university professors witnessing and making records of over 15,000 cases of face-to-face selling in buyers' offices, brought their conclusions down to six principles. They heard and saw both good and not so good salesmen. The simple rules found necessary to successful selling were:

1. During the course of a selling argument, do not talk too much yourself. Be a good listener first.

2. Watch out that you never interrupt a prospect when he is stating an objection.

3. Be careful that you do not slip into an argumentative attitude. Even without verbal expression, the attitude is easily conveyed.

4. During the opening phase of a business argument, inquire before the attack. See that the prospect fires most of his heavy ammunition early and then he will listen to you.

5. Whenever the prospect raises an important objection, restate the objection briefly but fairly. He thus knows you understand and will not repeat it.

6. After the preliminary maneuvering is over, concentrate if you possibly can on one key issue and refuse to digress from it. If the prospect brings up a minor issue consider it courteously but get rid of it. Otherwise the climax of the conversation is likely to be a discussion of conflicting points and the sale may be lost because the main question is sidetracked.

The value of the open door policy in plants is touched on in a short item commenting on an article by John I. Romer entitled "No Secrets—The Secret of Our Success." The item reads: "The key to American industrial progress is circulation of ideas. Executives, knowing that ideas are developed and perfected only when they receive the attention and thought of others, pass their successful sales and advertising plans on to industry. Old-fashioned traits of guarding business plans, refusing to exchange ideas and frankly discuss problems, have been practically banished from American business. 'The open door has displaced the bolted door. Operations behind closed doors look out infinitely more than they look in. The day is coming when business executives in all countries will appreciate the value of a free exchange of thoughts and experience on all matters pertaining to management of their organizations.' "

Nebraska Concrete Products Association

ROGER MERRITT, Secretary

THIS association's news letter is the means of doing a good work in keeping members posted, both on what is happening outside bearing on the industry and on the activities of members.

Announcement is made, in one instance, that the Diamond Concrete Products Company of Omaha is furnishing concrete block and tile for a new laundry building at Omaha covering a quarter of a block. The deep basement, it continues, will use 12-in. block and the first floor Meyer system of reinforced concrete. First floor walls will be light-weight Besser Dry Wall concrete tile.

Northwest Concrete Products Association

F. R. ZAUGG, Secretary

"THE PRE-CAST PRODUCT" is the title of this association's letter to members. The July issue, being published just previous to the mid-summer convention, devotes several pages to the details and trimmings of the program.

It features the fact that attendance at the meeting may be considered as combining business and pleasure since it was to be held at an inn at the snow line of Mt. Rainier and time for diversion is planned.

The balance of the 7-page letter is comprised of test results on brick and pipe and a column of notes from members.

Merchandising Manhole Block

Products Manufacturer Sells Manhole Block Over Wide Area

ONE of the pioneers in the manhole and catch basin block business, the Spencer Cement Block Works, Inc., Spencer, Iowa, holds what appears to be a unique record in merchandising concrete products.

Of 24 sewer jobs on which their units have been used in the construction of manholes and catch basins, the next to the smallest order was an "at-home" order. That is, a job in Spencer required only 2,000 block, whereas thousands of units were sold in other sections of Iowa, and in Illinois, Minnesota, Michigan and Wisconsin. It is interesting to note that the largest order, according to D. R. Dickey of the Spencer Company, required them to supply 80,000 manhole block for the village of Bellwood, Ill., a suburb west of Chicago. Some of the other principal jobs on which their manhole block have been used are listed here:

Berwyn, Ill., 50,000 block; Clear Lake, Ia., 40,000; Phillips, Wis., 36,000; Waseca, Minn., 36,000; Mt. Prospect, Ill., 30,000; Niles Center, Ill., 20,000; Fort Dodge, Ia., 18,000; Caspian, Mich., 15,000; Correctionville, Ia., 11,000; North St. Paul, Minn., 10,000; Des Moines, Ia., 10,000; Sioux Rapids, Ia., 10,000; Mankato, Minn., 9,500; Wanamingo, Minn., 7,800; Newton, Ia., 7,500; Faribault, Minn., 7,000; Mabel, Minn., 5,200; Hinton, Ia., 5,200; Sioux Falls, S. Dak., 5,000; Mason City, Ia., 4,200; Marion, Ia., 2,600; and Jordan, Minn., 1,000.

Stockpile of manhole block

It is evident from the successful way in which the Spencer company has merchandised manhole block that the product has unlimited possibilities. At present, a survey indicates that its use is not widespread like other concrete masonry units—building block, brick and tile—but that only certain sections of the country, principally Iowa and Illinois, have made extensive use of manhole block. This certainly indicates that manufacturers have been overlooking the opportunity to "put manhole block across," even though it would be to their advantage to do so.

There are exceptions to this, of course, but the manufacturers of manhole and catch basin block are in the minority. What few have entered the business, however, have been more than successful. Julius Sorenson & Sons, Racine, Wis.; Stone Brick & Block Works, Chicago, Ill.; Midwest Concrete Pipe Co., North Manchester, Ind., and Franklin Park, Ill.; Edgar D. Otto, Downers Grove, Ill.; E. L. Ramm, La Grange, Ill.; Des Plaines Concrete Products Co., Des Plaines, Ill.; J. A. Ross & Co., Chicago, Ill., and the Elmhurst-Chicago Stone Co., Elmhurst, Ill., all have made a success of the manhole block business.

Manhole and catch basin block manufactured in the plant of the Spencer Cement Block Works, Inc., are marketed in several states

New Officers of Quantity Surveyors' Institute

The American Institute of Quantity Surveyors held its third annual convention at the Pennsylvania Hotel, New York City on June 25th to 27th.

The discussion following presentation of papers on uniform methods resulted in a movement to bring about a method of measurement of quantities in all branches of the building trades.

The convention was addressed by Col. Ernest A. McCullough, an editor; John G. Ahlers of Barney Ahlers Co.; Alfred Fellheimer of Fellheimer & Wagner, architects, and Keith B. Hudson, architect of Sydney, Australia.

The following officers were elected for the ensuing year: Oscar Euphrat, president; Frederick H. Hunter, first vice-president; C. L. Weeks, second vice-president; F. E. Dischner, secretary, and C. T. Burman, treasurer.

Reinforcing Institute Meeting

The fall 1928 meeting of the Concrete Reinforcing Steel Institute will be held on October 1st to 3rd, inclusive, at the Buckwood Inn, Shawnee-on-Delaware, Pa.

This location is on a main railroad line at the Delaware Water Gap, and near Stroudsburg and 2½ hours from New York City.

Volume Changes in Hydrated Portland Cement

What Happens When Portland Cement Hardens—Expansion and Contraction with Change in Moisture Content—Changes in Volume, Weight and Specific Gravity of Cement Bars in Water—Infiltration

By ALFRED H. WHITE
Professor of Chemical Engineering, University of Michigan

PORTLAND cement clinker is composed in part of rather definite crystalline compounds and in part of amorphous slag. There is some dispute about the exact formula for the definite compounds, but it is agreed that they are basic silicates and aluminates of lime. When water is brought in contact with ground clinker, the constituents react and form compounds which are in part crystalline and in part amorphous. The character of these hydrated compounds depends upon a number of factors, but largely upon the amount of water used.

Several investigators have attempted to determine the products formed when cement reacts with an excess of water, but have only established that the products hydrolyze, as was to have been expected, calcium hydroxide going into solution and more siliceous products remaining in the solid state. Treatment of these solid products with successive portions of fresh water gave a continually changing product without a definite limit being reached. This procedure throws very little light upon the reactions when portland cement is used as a structural material, for an excess of water is never employed when portland cement is used in practice, and the calcium hydroxide formed through decomposition of the cement clinker separates in the solid phase as one of the constituents of the concrete. In practice, from 50 to 75 pounds of water are used for each 100 pounds of cement.

Hydration of Cement

There is no definite or theoretical amount of water which can be said to enter into combination with portland cement. For gypsum, which is one of the simplest hydraulic cements, a definite equation is usually written with the final product expressed as $CaSO_4.2H_2O$. Portland cement has various components and some of them, at least, do not form crystalline compounds. The case is further complicated by the fact that even though the cement is very finely ground, it is only the external surface of the fine cement particles which react with water. If concrete which has been under water for years is examined microscopically, it will be found that there are still nuclei of unchanged portland cement clinker which have failed to hydrate.

The first clear treatment of the reactions which take place on the hydration of portland cement were contained in a study by H. Le Chatelier[1] in 1889. The next important contribution was made in 1893 by Michaelis,[2] who enunciated the colloidal theory of the hydration of cement.

It was H. Le Chatelier[3] again who, in 1900, showed that there was an absolute decrease in volume of the wet paste during the hardening process. This was later confirmed by Kuhl,[4] one of whose experiments may be cited. A paste made from 250 grams of cement and 200 cc. of water was put into a graduated flask and the space remaining above the paste was filled to the graduated mark with clear water. There was a shrinkage after three hours of 1.4 cc., after twenty-four hours of 5.0 cc., after seven days of 10.6 cc., and after twenty-eight days of 13.6 cc. All cements showed this contraction, which continued up to the time when expansion of the cement in the bulb of the flask cracked the glass.

Quantitative measurements of the slow expansion of cement while it lay in water were first made by Bauschinger[5] in 1879. It became well established that bars of wet portland cement expanded during the first year of immersion in water and then reached a steady state with an elongation of from 0.10 to 0.15 per cent. It was also well known that bars of wet cement kept continuously in air after they were removed from their worlds, showed a shrinkage for several months, but ultimately reached a fairly steady state with a decrease in length of from 0.24 to 0.39 per cent.

Expansion and Contraction with Change in Moisture Content

It fell to the present author[6] to first show that cement bars which had reached a steady state in either air or water, changed their length with their moisture content and could be made to vary from 0.15 to 0.25 per cent in length with each alteration between the wet and the dry state.

This is illustrated in Figure 1, which shows the changes which have taken place in two bars of neat cement during a period of more than 19 years. Both E and G were commercial cements, complying with standard specifications, which were made into bars approximately 100 mm. long and 25 mm. square, with glass plates cast in the ends to give a smooth surface of contact for the micrometer. They were mixed with water to normal consistency, moulded and kept damp for 24 hours, after which they were removed from the moulds and measured. This measurement was taken as the zero measurement and all elongations were recorded as plus variations, and all contractions as minus variations from this original zero length. It will be noted that in each case there was slow expansion while lying in water at room temperature and that a constant length was reached after a year. After approximately three years in water the bars were placed in dry

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[1] *Annales des Mines*, 1887, p. 345.

[2] *Chem. Zeit*, 17, (2), 1243 (1893).

[3] *Bul. Soc. de l'Encouragement*—5th Series, V. 5, p. 54.

[4] *Tonind. Zeit.* 36, 1331 (1912).

[5] Mitt. Lab. Techn. Hochschule Munchen, Heft 8, 1879.

[6] *Proc.* Am. Soc. Test. Mat. XI, 531 (1911), and XIV, 203 (1914).

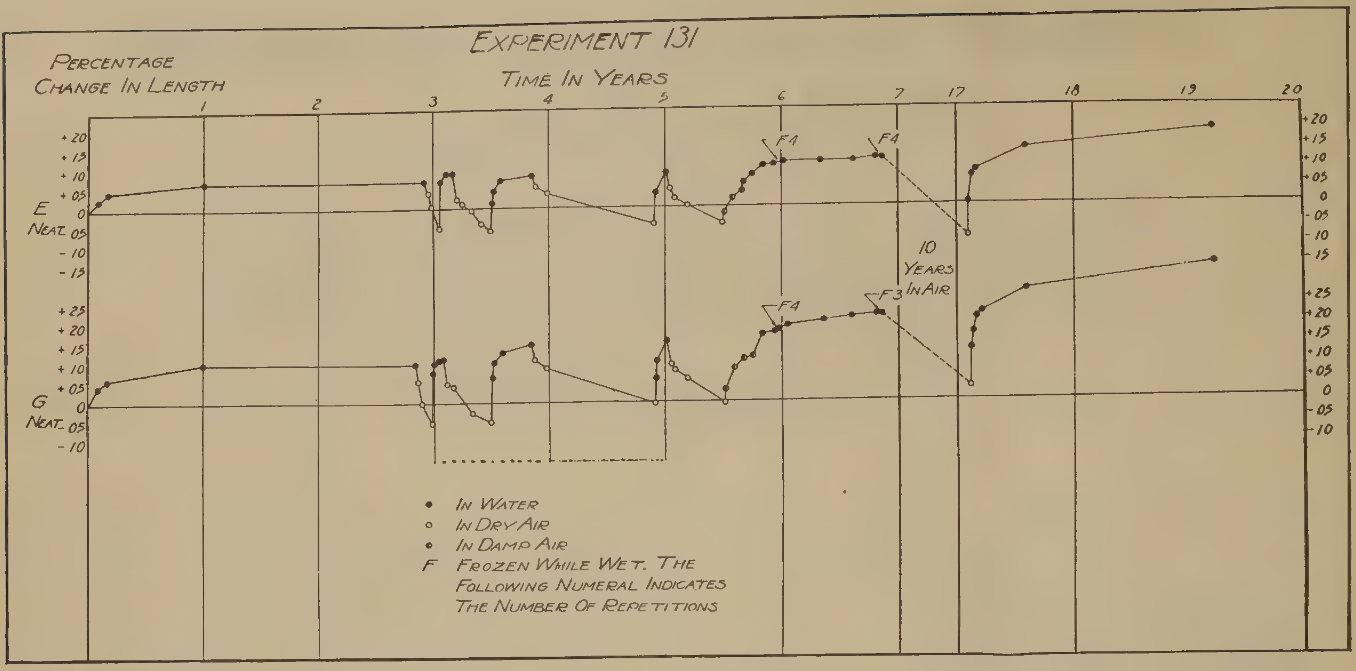

Figure. 1. Percentage changes in length of bars of neat cement when wet, dried, exposed to damp air and frozen while wet

air at room temperature, with a resultant gradual contraction which caused the bar to become shorter than its initial measurement. On reimmersion in water, expansion resulted, and this same cycle of changing length has been repeated with each change in environment.

This behavior is not peculiar to these two cements, but is characteristic of all portland cements, even those of rather unusual composition. The obvious explanation is that the colloidal gel maintains its reversibility at atmospheric temperature for a very long time. The behavior of bars made in this laboratory which have been under observation for more than 20 years substantiate this explanation, and test bars cut from old sidewalks permit the conclusion to be extended to still older specimens.

The alternations in length as shown in Figure 1 not only continue without diminution but actually increase in amplitude with successive swings. This is quite clearly due to the incomplete hydration of the particles of portland cement clinker. Microscopic examination of bars of cement which have been in water many years showed unchanged nuclei of cement clinker imbedded in a dense mass of alteration products. Water continues to act on the clinker until the gel becomes packed so tightly that no more water can force its way through. The cement or concrete will retain this condition unchanged so long as it is immersed in water. If the water is removed by evaporation, the dehydrated gel shrinks and the mass becomes porous. When it is again immersed in water, capillary action carries the water rapidly through the shrunken colloid to the particles of unchanged clinker, with the result that additional hydration products are formed, with a consequent increase in length over anything attained previously. On the first reimmersion in water at the end of the third year the expansion was about 0.15 per cent. The latest immersion for two years shows an expansion of 0.27 per cent for one cement and 0.31 per cent for the other.

The effect of damp air is also shown in Figure 1, where, between the fifth and sixth years, the bars after being air-dried were exposed to air almost completely saturated with water at room temperature. It will be noted that almost two-thirds as much expansion took place in damp air as on previous immersion in water for a similar period. The expansion of Bar E in damp air amounted to 0.08 per cent in two months, and the expansion of Bar G amounted to 0.12 per cent after three months in damp air.

The effect of freezing is indicated on these same curves by the letter F, which indicates that the bar was frozen while saturated with water. It will be seen that several successive freezings did not affect the length of the bar materially. A fuller study will be found further on in this paper.

Behavior of a Clay Brick

The behavior of a clay brick when immersed in water is shown in Figure 2. This was a common brick taken from an old stuccoed building which was being torn down. An expansion bar was sawed from it and studies were made, not only of changes of length but also of changes in weight and apparent specific gravity. The changes in length between the wet and dry state are less than one-tenth those noted with neat portland cement and amount to only about 0.02 per cent. The brick is rather soft burned and porous and absorbs 90 per cent of the total water in two hours, and practically all of its water within a few days. The apparent specific gravity rises in the same period from 2.03 to 2.08 and stays constant. As a check on some later work, figures were obtained on immersion in benzol with a similar result. To make the figures comparable on the graph, the changes in weight and specific gravity on immersion in benzol are calculated to what they would have been if benzol had the same density as water.

A more detailed study of the effect of water on a bar of neat cement is given in Figure 3. This was a commercial cement which passed the standard specification and was made into a paste of normal consistency and moulded into a bar. The bar was removed from the mould after 24 hours and measured. It was then kept alternately in air and water as shown on the graph and gradually became longer so that its length at the end of five years was +0.23 per cent when it had been soaked in water for about a year. It was then set aside and allowed to rest for eight

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A paper presented under the title, "Hydrated Portland Cement as a Colloid," at the Colloid Symposium.

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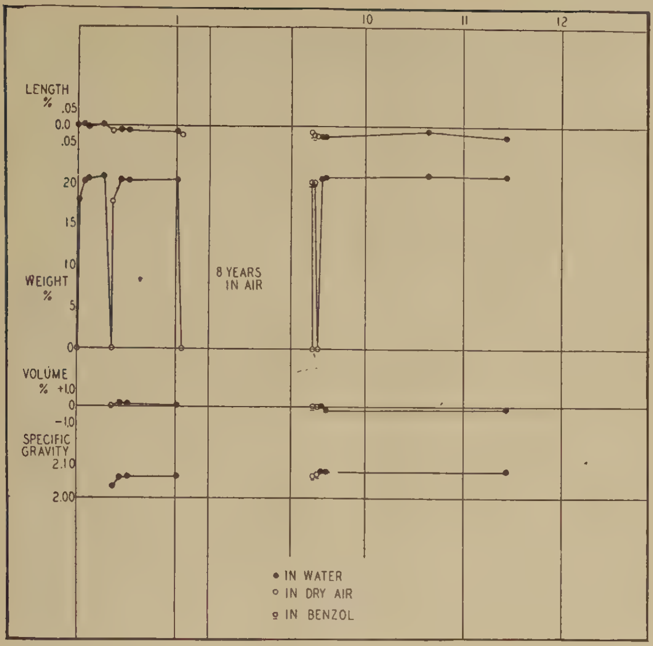

Figure 2. Percentage changes in length, weight and volume, and variations in apparent specific gravity of a clay brick when wet, dried and immersed in benzol

years in air dried with calcium chloride. When experiments were resumed, the bar was first soaked in benzol, then dried, and again immersed in water.

Details of the behavior of the bar in benzol and in water are given in the lower part of Figure 3, although even in the detail the scale is not large enough to permit all of the tests to be shown.

The dried bar was first immersed in benzol in a vessel which was evacuated until the benzol boiled, and the bar was kept immersed in the benzol boiling at room temperature for half an hour. The bar was then measured, weighed in air, and suspended in benzol so that its specific gravity could be calculated. It was at once put back in benzol which was boiled at room temperature for another half hour. This was repeated five times and yet after these treatments the bar had absorbed less than 0.4 per cent of benzol by weight. It was then allowed to lie in benzol at atmospheric pressure, with occasional measurements, as shown on the graph, for 19 days. It increased in weight 3.5 per cent in this period and its apparent specific gravity rose from 2.218 to 2.279, but its length and and its volume as determined by the benzol displaced did not change in any significant manner.

Infiltration

The slow infiltration of the benzol indicates that the

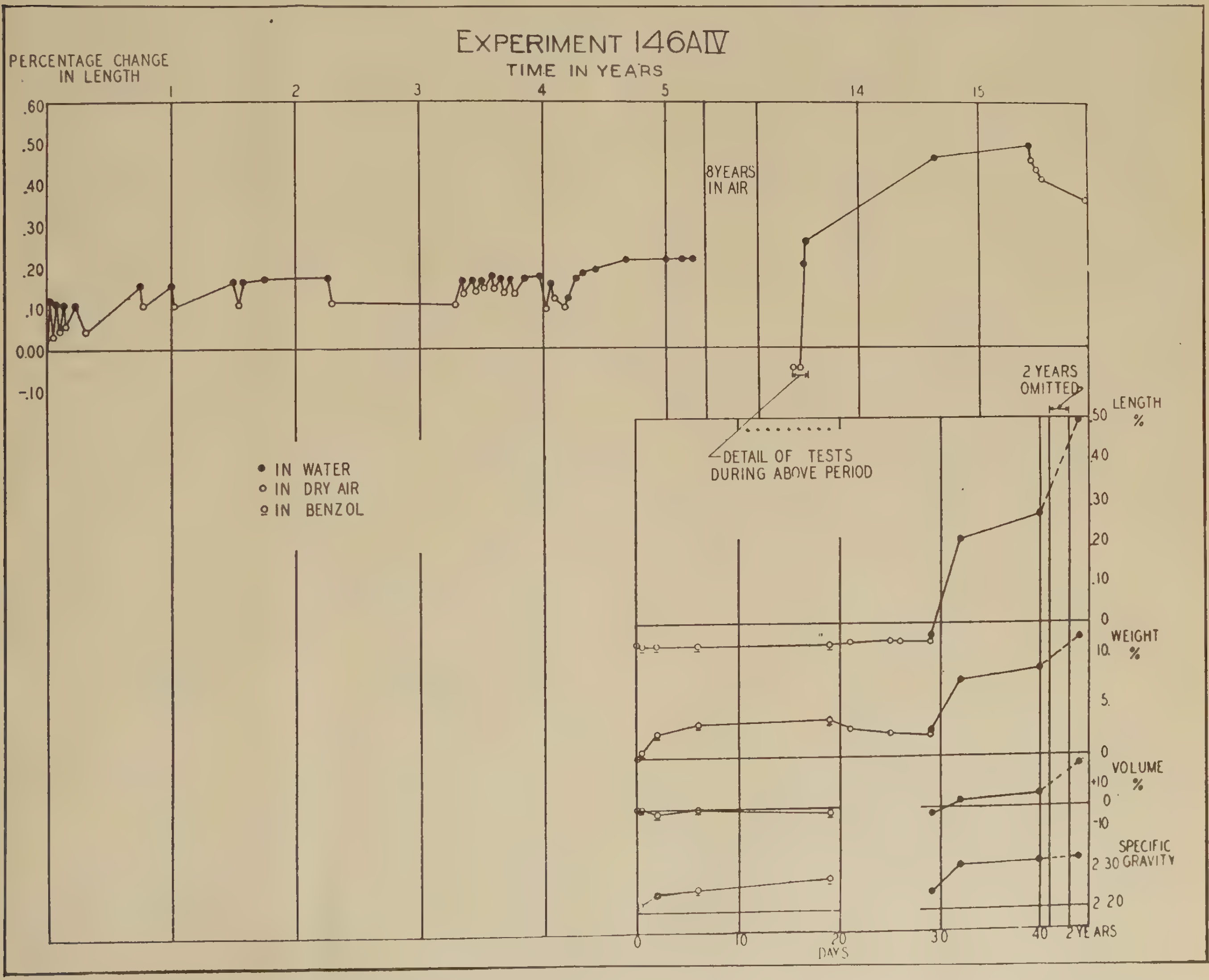

Figure 3. Percentage changes in length, weight, and volume, and variations in specific gravity of a bar of neat cement when wet, dried, and immersed in benzol. The values for increase in weight and specific gravity on immersion in benzol have been recalculated to the basis of water

capillaries were very small. Other work in this laboratory has shown that the capillaries of old cement bars became almost choked at the surface with calcium carbonate formed from calcium hydroxide which is drawn to the surface through the evaporation of water. The capillaries of the interior of the bar were probably not so minute as those at the surface. It seems fairly evident that the only action taking place in benzol was the slow infiltration of the liquid, which gradually filled the capillaries, causing an increase in weight and apparent specific gravity without any measurable increase in length or volume. In the graph of Figure 3, the increases in weight and volume have been recalculated to what would have been shown if benzol had the same density as water. This allows a direct comparison on the graph. The bar was then removed from the benzol and placed in a stream of dry air for 10 days. This was not long enough to remove all of the benzol, since the weight did not drop entirely to the initial figure.

The next step was to immerse the bar in water and an attempt was made to accelerate the infiltration by a partial vacuum. The increase in weight during the first half hour's immersion was only 0.13 per cent, but on subsequent immersions at atmospheric pressure, water continued to be absorbed, slowly, to be sure, but distinctly more rapidly than was the case with benzol. A more noteworthy difference was the expansion that accompanied the absorption of water. In three days the linear expansion amounted to 0.23 per cent and it rose more gradually, as shown by the graph, to a total linear change of 0.52 per cent in two years. The changes in volume computed from the weight of water displaced are even greater than those obtained by direct linear measurement and indicate that the water had not penetrated to the center of the bar, only 25 mm. square, even after two years. It is probable that the colloid in the outer envelope became so dense that no more water could force its way through it. The bar was, therefore, not homogeneous, but consisted of an expanded envelope in compression surrounding a core which was in tension. The measurements of length reflected the resultant of these two opposing stresses.

The graph of Figure 3 ends with a record of the length of the bar after six months in dry air. At the present time the bar has been in dry air for two years and one month, but it is still showing a length of +0.315 per cent and a weight of only +0.95 per cent. There is a permanent expansion out of all proportion to the amount of water retained. This is explicable on the theory of hydration of clinker which had not been in contact with water previously.

Internal Pressures Produced by Adsorption of Water

An excellent review of the heat effects produced by adsorption and the consequent pressure which may be calculated has been given by Browne and Mathews.[7]

Lamb and Coolidge[8] showed that the compression of vapors adsorbed by charcoal as indicated by the heat of adsorption was in the neighborhood of 37,000 atmospheres. Harkins and Ewing[9] determined the volume of liquid adsorbed by thoroughly outgassed charcoal and calculated that water in the micropores of charcoal may be compressed about 25 per cent. Nutting[10] has recently calculated that the compression of water on the surface of silica sand may be 17,000 atmospheres.

It is not feasible to apply the technique of these investigators to portland cement because heat is evolved in the chemical reactions accompanying the hydration of cement. The hydration does not become complete, but fresh chemical action takes place with every immersion in water, so that it is not possible to obtain reliable figures from the heat effects. Neither is it possible to pump out adsorbed gases completely, because hydrated cement is altered by heat and gives up moisture for a long time in even a very incomplete vacuum. No attempt has, therefore, been made to determine the heat effects due to adsorption.

An attempt has been made to draw some conclusions from the increase in specific gravity. The apparent specific gravity of these bars was determined by weighing the bars while suspended in water (or benzol), removing from the liquid, wiping off the surface and weighing the bar quickly in the air. This latter process involved an error of appreciable magnitude which was reflected in an error of about three points in the third decimal place in the specific gravity. This was not large enough to obscure the trend of the results, which change in the case of the bar of Figure 3 from a specific gravity of 2.218 to one of 2.324, which is 35 times the probable error. The meaning of the increase in specific gravity is obscured by the compression of the gas remaining in the voids.

The slope of the curve of Figure 3, showing increase in weight when immersed in benzol, indicates that absorption was nearly complete in 19 days. The absorption of benzol did not cause any measurable increase in volume but did cause an increase of apparent specific gravity due to slow displacement or compression of the air in the capillaries. The absorption of water caused an increase of 2 per cent in volume and an increase in specific gravity much larger than that caused by benzol.

If it could be assumed that the volume of water in the capillaries was equal to the volume of benzol previously absorbed, and that the balance of the water was adsorbed in the micropores and was responsible for the expansion noted, it would permit calculation of the compression of the water. On this basis it would appear that the water in the micropores was compressed to less than half its initial volume. The uncertainties surrounding this calculation are evidently large, and little reliance is attached to it, except as a qualitative indication that pressures of large magnitude are involved.

Other evidence of the pressures developed may be found in the expansion in damp air noted in Figure 1. The data are more complete for Bar G, and the numerical data for the test on this bar are given in Table I.

Table I

Changes in Length and Weight of a Bar of Neat Cement in Air Saturated with Moisture at Room Temperature

	Length	Weight
On removal from dry air	—0.002%	138.95 g.
7 days in damp air	+0.028	
1 month in damp air	+0.085	
2 months in damp air	+0.103	141.37 g.
3 months in damp air	+0.116	142.35 g.
2 hours in water in vacuum	+0.125	144.00 g.
1 month in water	+0.174	146.67 g.
2 months in water	+0.178	146.80 g.

It is apparent that the increase in length proceeds more rapidly than the increase in weight. It is probable that it is the expansion of the outer layer which affects the length and that the slower penetration of moisture to the center relieves the tensile strains but does not cause commensurate increase in weight. Immersion in water causes further expansion and increase in weight as shown.

The high pressures which have been determined by others as existing in the micropores of loose granules do not indicate the pressures which might be directed externally to cause deformation of solid bodies. The expansion of concrete gives some measure of this external pressure although the situation is complicated by the probability that some fresh cement clinker is hydrated every time that concrete is moistened.

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[7] Alexander, *Colloid Chemistry*, Vol. I, pp. 450-470.

[8] *Jour. Am. Chem. Soc.* 42, 1146 (1920).

[9] *Jour. Am. Chem. Soc.* 43, 1787 (1921).

[10] *Jour. Physical Chem.*, April, 1927, p. 531.

Hydrated cement is, to some extent, plastic and has no well-defined modulus of elasticity. A figure of 5,000,000 lbs. per sq. in. is, however, rather frequently taken as an approximation of the modulus for rich mortars which have had adequate opportunity to harden. On this assumption, an elongation of 0.1 per cent corresponds to a stress of 5000 lbs. per sq. in. This is about the load which rich concrete will bear in compression, and from five to ten times the amount it will bear in tension.

The effect of expansion is evidenced in pavements and other structures exposed to the weather. The magnitude of the stress is in many cases sufficient to cause pressure ridges or upheavals in the concrete. The stresses produced by changes in moisture content constitute the fundamental cause of the disintegration of concrete as has been set forth more fully by the author elsewhere.[11]

Effect of Freezing While Saturated with Water

Freezing cement bars while they are saturated with water should cause an expansion which is a function of the amount of liquid water which the bars contain. Experiments were made by measuring the bars when removed from water, freezing them, measuring them while frozen, thawing them under water and measuring them again. The chief error in this work is due to the change in the length of the cast iron yoke of the micrometer with change in temperature. The co-efficient of expansion of cast iron is closely that of cement, and the variation has not been determined for the lower temperatures. In this work, it has been assumed that the correspondence remains the same, and only the differential change in length between cast iron and cement has been measured.

That this experimental procedure is adequate is shown by the following illustration: A bar of rich lime mortar containing some portland cement had hardened for several months. It consisted of grains of sand, bonded together with crystalline calcium carbonate and a small amount of portland cement. Its water absorption was 15.1 per cent. This bar, frozen while saturated with water and measured while frozen at 27 deg. F., showed an elongation due to freezing of 0.085 per cent.

The neat cement bars of Figure 1 showed on the contrary an apparent contraction when frozen, the contraction becoming greater at the lower temperatures. Some data are given in Table II. The total amount of water in the bar was probably about 11.0 per cent and two-thirds of it was in such a state that it would evaporate in dry air. The bar of lime mortar noted above containing 15.1 per cent of capillary water expanded 0.085 per cent on cooling to 27 deg. F., but this bar of neat cement actually contracted slightly. The bar was six years old when tested and had been soaked two months in water just prior to the freezing tests so that there were no empty capillaries into which the ice formed could expand without causing an external stress. The explanation might be that the water was under such high compression that its freezing point had been lowered below 5 deg. F., or that the water was under such high compression that its freezing point was already in the solid state before it was frozen.

Portland cement clinker on hydration forms products some of which are crystalline and some of which form a stiff gel. This gel absorbs and gives up water with changing humidity of the air. A bar of neat cement may change in length more than 0.1 per cent with alteration in atmospheric humidity. The linear expansion when changed from dry air to water will be greater than this and may be as great as 0.5 per cent. The gel retains this reversibility at atmospheric temperature for at least twenty years, and there is nothing to indicate that it may not continue indefinitely. The magnitude of the expansion increases with the number of alterations between the dry and the wet state, due to the progressive hydration of particles of unchanged clinker. When a bar of hardened cement is transferred from dry air to benzol, the capillaries become slowly filled with benzol with resultant increase in weight and apparent specific gravity, but without any change in the length of the bar. When the same bar, after evaporation of the benzol, is transferred to water, the capillaries become filled with water with a resultant increase in weight, apparent specific gravity and length. The volume of water adsorbed may be three times as great as that of the benzol absorbed in the prior test. If it be assumed that the benzol filled the larger capillaries and that the surplus volume of water was all adsorbed in the micropores, the increase in volume of the bar should give a measure of the compressed volume of the water. An assumption of this sort indicates that the water was compressed to half its volume, but the figure cannot be given much weight because of the uncertainties as to the amount of air remaining in the capillaries on immersion in benzol and in water respectively. So also the increase in apparent specific gravity cannot be given much weight in computing pressures. Freezing tests on bars of well hardened neat cement saturated with water fail to show any expansion although the bars contain about 11.0 per cent of water of which two-thirds is in such a form that it will evaporate in dry air and be absorbed again on immersion in water. In fact the bars of cement shrink to a greater degree than cast iron as the temperature drops further below the freezing point. This failure to expand at the freezing point may indicate a very high compression of the water or it may indicate that the water was already in the solid state before it was frozen.

The pressures due to adsorption are mainly internally directed, but they do produce a deformation of the bar. The modulus of elasticity of hardened cement mortar is low and hydrated cement is somewhat plastic. A compressive stress of about 5000 pounds to the square inch will produce rupture of even the best concrete. The disintegration of concrete exposed to the weather is largely due to the expansion and contraction of the colloidal material coupled with the progressive expansion due to the hydration of fresh portions of cement clinker with each long immersion in water.

Table II

Variations in Length of a Bar of Neat Cement Successively Frozen and Thawed While Saturated with Water

Length of Bar in mm.		
Immersed in Water at Room Temp.	Measured While Frozen	Temperature When Measured
102.828	102.812	5 deg. F.
102.823	102.815	6 deg. F.
102.825	102.816	9 deg. F.
102.824	102.821	23 deg. F.
102.825	----------	----

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[11] *Concrete*, 1925.

Mixer Musings

Reported by "Joe"—The Mixer Boss.

Quality Control—In Spots

DEAR Joe:—

In my official capacity as a Certified Slump Tester, I feel that it is up to me to take a look at some of the other concrete jobs going on in my neck of the woods. We all like to bolster up our own feeling of accomplishment by finding somebody else who isn't quite as good as we are.

Well, with this explanation off my chest, I'll get down to brass tacks. The other day, while my test cylinders were curing, I went down the street to see how Bill was getting on with his job. Bill is not a Slump Tester and I, for one, would blackball him if he tried to join up. Why? That's the point of my story.

As I was saying, I visited Bill on his job.

"Quality control?" says Bill, "that's what we ain't got nothing else but."

And I had to admit that Bill sure was right. They had all the newfangled measuring boxes, inundators and whatnots. An inspector was Johnny-on-the-spot at the mixer and the concrete that came out of that drum was quality, if ever any concrete was. A nice stiff mix; no segregation; and it looked like concrete that could be put in the forms without trouble. I never did see nicer concrete.

"Bill," says I, "I'll have to take off my hat to you. That there *is* concrete. Have any trouble placing it into the forms?"

"Not a bit" says Bill, "let's go see them place it."

Sure enough, when we got to the place where the concrete was chuted, there it was as workable as you could hope to see concrete. In fact it looked too darn workable to me. And every once in a while it was plain slop. Here was another mystery greater even than that of the lost slump cone. So, thinks I, I'll just appoint myself Duff, the great Investigator, and see what was up. Somehow the thing looked fishy to me.

"How's that for workability?" asks Bill.

"Well," says I, "if workability means wet, you certainly got it. But why in blazes you take the trouble to make such good concrete at the mixer and then put this soup into the forms, I can't see."

"You see, it's like this," explained Bill. "When they tried to place that nice dry concrete, they found that it was necessary to spade and puddle it in the forms. So we had to do something to make it more workable. The simplest way out was to put a hose at the top of the chute and add water to the concrete as it slid down. When we did that our problem was solved."

"Well, I'll be ——"

"But you should see the results of some of the tests made from the concrete taken from the mixer!" says Bill.

And that's why I feel that Bill is not a true Slump Tester and I warn you to look him up when he sends his application in.

Yours, drier and drier,
Jim, C. S. T.

We'll be on the watch, you bet, Jim.

Joe, the Mixer Boss.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit, Michigan.
Twenty-fifth annual convention, Book-Cadillac hotel, Detroit, Mich., Feb. 12th to 14th.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth St., New York City.

American Road Builders' Association; Miss E. A. Birchland, Secretary, 29 W. Thirty-ninth St., New York City.
1929 convention and road show, Cleveland, Ohio, Jan. 14th to 19th.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 W. Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer, Secretary, 1150 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; Wharton Clay, Commissioner, 123 W. Madison St., Chicago.

Association of Cast Stone Manufacturers; Frank M. Brooks, Secretary, Pasadena, Calif.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Concrete Products Association; F. O. Matthiessen, Secretary, 644 Drexel Building, Philadelphia, Pa.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.
Fall Meeting, Buckwood Inn, Shawnee on Delaware, Pa., Oct. 1st to 3rd.

Iowa Concrete Products Association; R. L. Gavin, Secretary-Treasurer, 1002 Hubbell Bldg., Des Moines, Iowa.

National Association of Building Trades Employers; A. W. Dickson, Executive Secretary, 2226 Builders Building, Chicago, Ill.

National Association of Builders' Exchanges; Earl F. Stokes, Secretary, 15 E. Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 E. Twenty-second St., New York City.

The National Lime Association; J. L. Durnell, Chairman, Executive Committee, 927 Fifteenth St., N.W., Washington, D. C.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Building, Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Building, Cleveland, Ohio.

Northwest Concrete Products Association; F. R. Zaugg, Executive Secretary, 803 Seaboard Building, Seattle, Wash.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 W. Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Building, 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 3115 Plankinton Arcade, Milwaukee, Wisconsin.

New Equipment and Materials

Telescoping Material Bin Folds into Columns

Having completed the design of numerous other styles and sizes of bins, the Butler Bin Company, Pittsburgh, Pennsylvania, has now turned its attention to the Butler telescoping bin. It is designed expressly for use in metropolitan areas where transportation through city streets is a problem or in excavations where the ordinary bin cannot be conveniently located.

The bin itself telescopes into the columns and is raised or lowered by four windlasses. After the bin is raised to the proper height, the columns are fastened, giving support said to be entirely adequate. For use in transporting, there are two rubber-tired wheels.

The bin may be moved by unbolting the corner columns, telescoping it into the column frames and attaching the wheels.

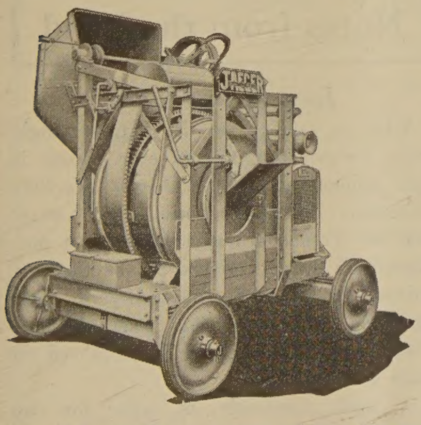
Complete Manufacture of Finest Wire Cloth

Wire cloth of 160,000 square openings per square inch and said to be the finest in the world has just been completed by the Newark Wire Cloth Company, of Newark, N. J. In commonly used terms, it is "400-mesh" cloth.

Heretofore, one of the finest wire cloths made in the United States has been 325 mesh and it also was made, it is claimed, by the Newark Wire Cloth Company. It is known as Sieve No. 325 by the U. S. Bureau of Standards and has been adopted as standard by the American Society for Testing Materials, it is said.

"Speed Queen" New Jaeger Mixer

The Jaeger Machine Company, Columbus, Ohio, has just made announcement of a new 7-S non-tilting concrete mixer, known as the "Speed Queen." It is mounted on four wheels, with a spring-hung chassis.

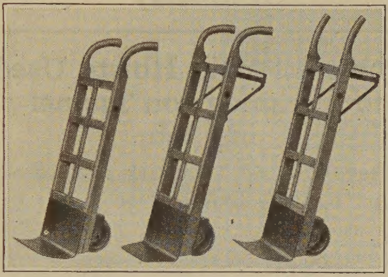


Its mixing time and time for discharge are the same as the "Speed King," a reputedly fast one bag trailer introduced by the Jaeger company a year ago.

Automatic skip shaker, accurate measure water tank, two-cylinder Le Roi engine are standard equipment. It is also built in low charge type.

New Model Bag Trucks Issued by Bates

Announcement has been made by the Bates Valve Bag Corporation, Chicago, of its three new models of bag trucks. No. 1 truck, the type used for loading, is 48 in. high and has curved handles and curved lip. No. 2, for warehouse use, has been designed with curved handles, straight lip of 6 in. and is equipped with or without foot supports. It is 52 in. high.



The third, a special purpose truck, is 54 in. high. It has straight handles with straight or curved lip and is equipped with or without foot supports.

One-Man Crane Features Versatility and Ease in Operating

Outstanding points that are featured by the manufacturers of a new type of Conco crawler crane are the low center of gravity and the resulting stability, ease of operation and speed, lower power loss and maintenance cost, and absence of friction clutches.

The Conco crawler crane, according to the manufacturers, H. D. Conkey & Company, Mendota, Ill., is gasoline or electric operated, self-contained, full circle and designed to run on Conco endless tread traction.

Designed for rapid handling of material for hook block, grab bucket and dragline bucket work, it is strictly a one-man crane, functioning in all operations from the operator's deck near the front end of the cab.

These crawlers are at the present time being built in ½-, ¾- and 1-yd. capacities.

Bulldog Tie Rod Clamps Eliminate Spacers

Bulldog take-up tie rod clamps, manufactured by the J. M. Willard Company, Los Angeles, California, are made entirely of steel with case-hardened threads. No spacers are said to be required and one tie rod may be used where four or more wire ties would be needed, it is claimed.

According to the manufacturer, they can be installed with a carpenter's hammer and removed with hammer and wrench. In using, the tie rod is made up to length on the bench with its two sleeve nuts and placed in the form as a spacer. The clamp bolts are then inserted through the form facing and screwed into the sleeve nuts, using the loose wedge as a wrench. The wedge is then driven in, which takes up all slack and rigidly locks the form.

A special wrench furnished by the manufacturer is designed to back off the slotted head of the sleeve nut from the tie rod.

Metro-Nite, White Aggregate, Widely Used in Products Plants

Large cast and trim stone producers, particularly in the Middle West, are said to be users of Metro-Nite, a white aggregate furnished in all sizes necessary for the manufacture of concrete products. Included is a ⅛-inch size for facing concrete block.

In the manufacture of trim stone, according to the manufacturers, the use of Metro-Nite effects a saving of more than 50 per cent on white cement. The Metro-Nite Company, Milwaukee, Wisconsin, is the manufacturer.

Clinton Ready-Mixed Concrete Truck

The Clinton concrete truck is built to supply the needs of central mixing plants for transportation of ready-mixed concrete. It is, however, sold, on contract, as a unit of a standard plant, consisting of storage bins, weighing hoppers, batch mixer, and a cement conveyor with skip weighing device.

The truck has a revolving body holding 3 cubic yards of concrete. The body after loading is hermetically closed and revolves in transit at the rate of 8 to 12 revolutions per minute, depending upon the speed at which the truck is traveling.

The Clinton Motors Corporation is at Reading, Pennsylvania. W. A. Olmstead is the New York representative.

About Makers of Equipment and Materials

INDUSTRIAL LITERATURE

Material Handling Catalog

The Lewis-Shepard Company, Boston, Massachusetts, has just announced as available upon inquiry a 36-page publication apparently covering completely the service rendered on standard materials handling equipment and special installations where conditions are out of the ordinary.

The catalog is entitled *"Lewis-Shepard Engineering"* and covers such equipment as elevator trucks, portable elevators, platforms and racks, and hand trucks, carts and barrows.

Weigh Box Folder

The *Madsen* combination adjustable volumetric and weigh box is completely described and illustrated in a broadside published by the *Madsen Iron Works,* Huntington Park, Calif.

This is a two-compartment batch box weighing or measuring sand and rock simultaneously, it is said. Where more than two sizes are specified, the publication states, the operator can put out a batch a minute by using the 5 to 1 knife edge scale. A latch control at discharge gate and an automatic counter-balanced closing device and lock are installed to minimize labor. Controls, the circular states, are so arranged that gang operation is integral, a single gate providing constant center discharge into the truck.

New Handbook

Completely revised and containing the latest formulas and working tables, a new edition of the Marsh-Capron handbook for various construction operations is now being distributed through the company's main office, Chicago, and the Marsh-Capron representatives in various cities.

Details of methods and short-cuts for saving time, labor, and material form a part of this edition, which is well illustrated with photographs and drawings of actual operations. Ways of eliminating the usual wastage and at the same time speeding up the work and doing a better job are found in the first sections. Recommendations for securing the best results on trim, ornamental, and stucco processes are also given.

Included in the formulas for various kinds of plaster are those for hydrated lime plaster with dry and putty mixes for base coats, three coat work, and finish coats, gypsum cement plaster for scratch coats, second coats, and for plastering or brick or tile, portland cement plaster, and portland cement stucco.

One of the convenient features of the handbook is a table for figuring room yardage. This is said to be accurate to within .2 of a sq. ft. and is calculated for 10 ft. ceilings. However, an easy table of corrections is provided so that the yardage for any height ceiling can be found quickly.

NEW EQUIPMENT
(Continued)

Three Electric Hoists Used to Advantage on Tunneling Job

Three Novo single-drum, electric-powered hoists, handling both spoil and sewer lining materials, were used in an interesting way on sewer tunneling jobs in Detroit, Mich., by Louwers and Sumerville.

A bin was built half way up the head frame over the excavation to hold excavated material. Trucks were loaded by gravity from this hopper. Above the hopper was a track and small industrial car, providing a platform for the spoil bucket to drop upon, emptying it. During the hoisting of the spoil bucket to the top of the head frame the car was rolled aside, the hoist operator controlling both the spoil bucket and car.

An electric-powered mortar mixer was placed at one side of the excavation, dumping into a bucket lifted and lowered by the Novo NH hoist. Brick, piled on the other side of the excavation, were lowered by the hoist down the shaft. Approximately 200 brick constituted a load, which, as in the case of the spoil, weighed, including the bucket, 1500 pounds.

India Rubber Pipe Joint Claimed as Watertight

A reinforced concrete pipe joint of india rubber, designed to be absolutely watertight, has been evolved in France and patented by Leon Bille. Elasticity and flexibility of the pipe lines, coupled with ease of installation in water, are said to be features of the joint.

In tests made no seepage was said to have been found up to a pressure of 1422 lbs. per sq. in.

On Finishing Accuracy of Planer

The Koehring Company, Milwaukee, Wis., has just completed the publication of its folder on its subgrade planer, calling attention to the accurate contour secured.

According to the publication, the planer is designed for all standard road widths and any standard concrete paving, with or without center joint. The machine is attached by two draw bars fastened to the front axles of the paver with special hub caps. It is placed close to the rear of the paver, just under the spreader bucket in its loading position.

On Conduit Manufacture

A small 8-page booklet published by the *Murray Conduit Systems,* New York City, illustrates what is said to be the first of its new type of conduit machines in operation, operated at an average speed of 117.7 ft. per hour.

Detail views show the revolving worms inside the hopper or feeding chamber, which carry the concrete from the hopper into the molding chamber, the revolving mandrels at the end which serve to polish the interior surface of each duct, and two parallel banks of conduit completed.

Super Cement for Stucco

A four-page folder published recently by the *Marquette Cement Manufacturing Company* deals with the use of *Super Cement* in the stuccoing of the Edgewater Beach apartment hotel, reputed to be Chicago's largest stucco job.

Super Cement is a tanno-catalyzed portland cement used especially for oil- and water-proof concrete construction.

Notes from the Field

Jaegers to France

What is said to be the biggest single order for concrete mixers ever placed is that announced by the *Jaeger Machine Company,* Columbus, Ohio, which states that the French government has just purchased 85 Jaeger mixers, 50 of the machines being 14-S, one-half-yard size, equipped with extension track loaders. The entire shipment will be employed on state work.

A week previously an order for two carloads of Jaeger mixers had been received from the Soviet government for immediate shipment to Russia, the firm states.